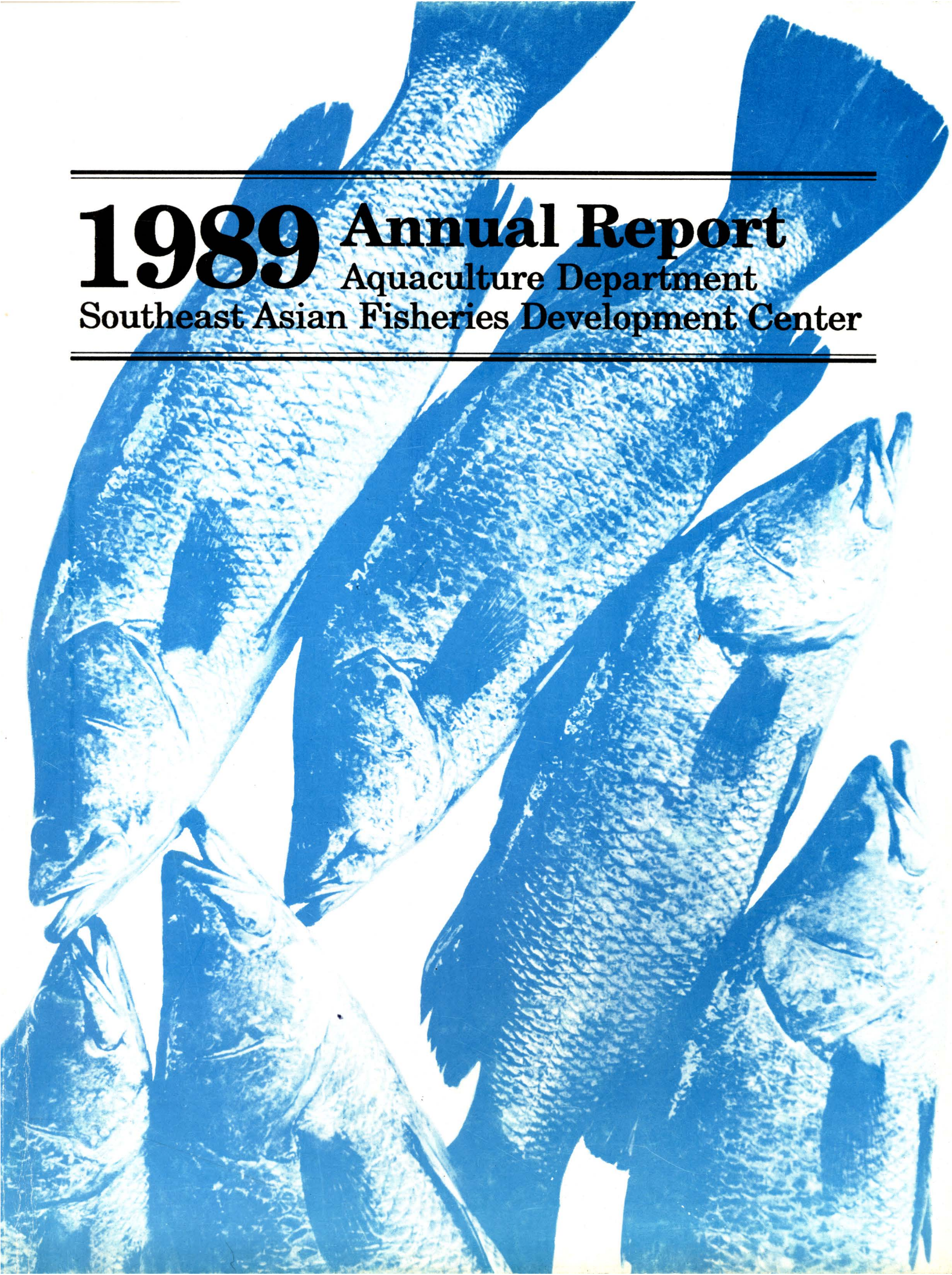
1989 Annual Report

Aquaculture Department
Southeast Asian Fisheries Development Center



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CONTENTS

ACRONYMS

ABOS	-	Algemeen Bestuur voor Ontwinkklingssamenwerking
AQD	-	Aquaculture Department of SEAFDEC
AQUASOC	-	Aquaculture Society, University of the Philippines in the Visayas
ARC	-	*Artemia* Reference Center of Belgium
BFS	-	Binangonan Freshwater Substation
BRAIS	-	Brackishwater Aquaculture Information System
CDS/ISIS	-	Computerized Documentation System, Integrated Sets of Information System
DA	-	Department of Agriculture
DAP	-	Development Academy of the Philippines
DECS	-	Department of Education, Culture & Sports
HUFA	-	Highly unsaturated fatty acids
ICLARM	-	International Center for Living Aquatic Resources Management
IDRC	-	International Development Research Centre of Canada
IFREMER	-	Institut Francais de Recherche pour l'Exploitation de la Mer
IFS	-	International Foundation for Science
LHRHa	-	Luteinizing hormone-releasing hormone analogue
LBS	-	Leganes Brackishwater Substation
NACA	-	Network of Aquaculture Centres in Asia
NBBP	-	National Bangus Breeding Program
PHILCITE	-	Philippine Center for International Trade and Exhibition
PHRDC	-	Philippine Human Resources Development Center
PRC	-	Publications Review Committee
RAFC	-	Regional Agricultural and Fishery Council
SEAFIS	-	Southeast Asian Fisheries Information Service
SGV	-	Sycip, Gorres, Velayo & Company
TRS	-	Tigbauan Research Station

OVERVIEW

Since its establishment in 1973, the Aquaculture Department (AQD) of SEAFDEC has adhered closely to its mandated functions:

- Promote and undertake aquaculture research relevant and appropriate for Southeast Asia;
- Develop human resources for aquaculture development in the region;
- Disseminate and exchange information on aquaculture; and
- Undertake such other activities as may be determined by the governing SEAFDEC Council of Directors composed of high-level government officials, one from each of the Member Countries: Japan, Malaysia, the Philippines, Singapore, and Thailand.

AQD conducts continuing research on the culture of economically important species in the region. In shrimp culture, AQD has generated technologies on broodstock maturation and spawning, larval rearing, diet formulation, and disease prevention and control. For milkfish, technology transfer has been achieved on broodstock maturation, spawning, egg collection, larval rearing, and fry production. Significant advances have been made in maturation, induced spawning, and larval rearing of sea bass and siganids, and in the induced spawning and seed production of carps.

Within the year, a total of 44 scientific papers published in local and foreign journals, proceedings and books resulted from AQD-conducted research studies. Verified results were techno-packaged into extension materials.

AQD's stature in the scientific community has been recognized by the awards it has won for scientific papers. In 1989, AQD won the Best Paper Award in the Fisheries and Aquatic Category in the first National Research Symposium sponsored by the Department of Agriculture-Bureau of Agricultural Research.

Short-term training courses continued to be offered, based on the aquaculture training needs of SEAFDEC Member Countries.

During the latter part of the year, AQD launched the seafarming and coastal enhancement project to improve the quality of life in impoverished coastal communities. To realize this objective, as with those of its other projects, AQD continues to strengthen its linkage with various governments and national and international organizations.

AQD researchers, University of the Philippines professors, and representatives from the private sector discuss priority areas for research and development, February 4, 1989.

RESEARCH

The 1989-1991 research programs of the Department were firmed up during a roundtable discussion held at the Tigbauan Main Station on 4 February 1989.

The discussion focused on current problems faced by the shrimp industry and the coastal communitites and on possible alternative species for aquaculture. It was participated in by the academe, the private sector, and the research institution represented respectively by professors of the University of the Philippines, industry consultants, and researchers of AQD.

Studies

Sea Bass (*Lates calcarifer)*

•Hormonal induction of off-season gonadal maturation and spawning of sea bass (*Lates calcarifer*) broodstock.

Mature sea bass injected once intramuscularly with 20 µg luteinizing hormone-releasing hormone analogue (LHRHa) per kg body weight at 1100 or 1700 H spawned at dawn or 33.7 to 40.0 h post-injection. Injection at 2300 or 0500 H resulted in spawning during the day or 38.0 to 47.3 h post-treatment. Mean egg production levels (26.8-34.4 x 10^4/kg body weight) were significantly higher among dawn-spawners compared with daytime spawners. These results demonstrate that the time of initial spawning varies with the time of day that LHRHa was injected and that the number of eggs shed is influenced by the time of day that sea bass spawned.

•Development of rearing techniques for sea bass (*Lates calcarifer*) larvae in floating cages in coastal waters.

Four age groups of sea bass fry (2-, 15-, 21-, and 37-day old) were stocked in net cages (1 x 1 x 1.5 m; 0.5 mm mesh) at 500-5000 fry per cage. Fish were fed chicken egg slurry, later with minced fish flesh. Mass mortality occurred 2 and 15 days after stocking respectively for 2-day old and 15- and 21-day old fish. Following 30 days of rearing, 37-day old fry had 4.5-7.1% survival, 13-14 mm length, and 69-97 mg weight.

•Evaluation of *Moina macrocopa* as alternative live food for rearing marine fish larvae: I. Use of *Moina* as partial or complete substitute for *Artemia* biomass in rearing postlarval sea bass (*Lates calcarifer*) with or without green water.

Fifteen- and 30-day old sea bass larvae had similar growth rates when fed *Moina, Artemia* or their combination. Larvae at 10 ppt had lower survival rates when fed *Moina* alone or in combination with *Artemia* than those fed *Artemia* alone at 32 ppt. Twenty-five-day old larvae consumed more *Moina* than 15-, 20-, and 30-day old ones irrespective of time after feed was given.

•Histochemical studies of the early stages of development of the digestive tract of sea bass, *Lates calcarifer* Bloch. (Thesis Research)

The digestive tract of newly hatched sea bass larvae is a simple tube which becomes differentiated into esophagus, stomach, and intestine in 2-day old larvae. From day 2 onwards, alkaline phosphatase and esterase were observed in the intestine. Esterase was further localized intensely in the esophagus of 5-day and older larvae. Alkaline phosphatase, esterase and aminopeptidase were present in the pyloric caeca and intestine of 20-day and older larvae. At 30 days post-hatching (end of metamorphosis) and onwards, the digestive tract was already well-developed and the enzymes alkaline phosphatase, esterase, aminopeptidase, lipase, protease and amylase were present in the pyloric caeca and intestine.

•The influence of temperature and salinity on the oxygen consumption of sea bass larvae, *Lates calcarifer* (Bloch). (Thesis Research)

Lates calcarifer larvae fed *Brachionus* on days 2 to 13, *Artemia* nauplii on days 13 to 25 and frozen subadult *Artemia* on days 25 to 55 grew and metamorphosed faster at decreasing salinity levels of from 30 to 10

ppt. Mean body weight and length were significantly different between 10 and 15 ppt, 15 and 20 ppt, and 20 and 25 ppt. Survival rate was highest at 15 ppt (96%) and lowest at 10 ppt (92%).

- **Integrated culture of sea bass and tilapia: The use of live tilapia as food for sea bass, *Lates calcarifer* (Bloch).**

Fish grown in earthen ponds in polyculture with tilapia attained higher mean body weight (106 g) and survival (31%) than those in ponds with net partitions (mean body weight, 82 g; survival, 22%) to separate the larger prey from the predator.

- **Economic analysis of an integrated sea bass (*Lates calcarifer*) production system.**

Preliminary cost and return computations of sea bass hatchery showed positive returns.

- **Effect of various dietary lipid sources on growth, survival and fatty acid profile of sea bass, *Lates calcarifer* Bloch fry.**

Soybean oil, cod liver, and coconut oil singly and in combination (1:1) were tested as sources of dietary lipid (at 9% level) for sea bass fry. A diet with 1:1 ratio of cod liver oil and soybean oil gave the highest growth and survival followed by cod liver oil alone and soybean oil alone. Growth and survival rates were poor in the coconut oil diet and poorest in the diet with no lipid supplement. Substantial saving in feed costs could be realized if soybean oil is partly substituted for fish oil.

- **Alternative sources of protein for fishmeal in *Lates calcarifer* diets.**

Soybean meal (SBM), shrimp head meal (SHM), meat and bone meal (MBM) were substituted in increasing proportions for fish meal protein in the feed for juvenile sea bass (mean weight = 0.67 ± 0.14 g). After three months feeding, survival ranged from 46 to 83%. SBM, SHM and MBM protein can replace respectively up to 10%, 20% and 20% of the fishmeal (40% protein) diet.

***In progress*:**

- Verification studies of hatchery production of sea bass, *Lates calcarifer*.
- Effect of temperature and ration size on growth and energy utilization of sea bass: Food consumption, feeding rate, salinity and temperature tolerance of sea bass fry and fingerlings.
- Food consumption of sea bass (*Lates calcarifer*) in captivity: Group feeding.
- Rearing of sea bass fry in various salinities.
- Osmotic and chloride regulation in juvenile sea bass, *Lates calcarifer* Bloch.

Grouper (*Epinephelus* spp.)

- **Induced spawning and larval rearing of groupers, *Epinephelus* sp.**

Seven monthly implantations of 17 α-methyltestosterone contained in a silastic capsule did not induce adult female grouper (3-9 kg body weight) to invert sex. A single implantation of pelleted luteinizing hormone-releasing hormone analogue also did not trigger spawning.

- **Induced sex inversion in juvenile grouper, *Epinephelus malabaricus*, using 17 α-methyltestosterone.**

Juvenile female grouper showed signs of sex inversion three months after biweekly injections of 17 α-methyltestosterone (MT) at doses ranging from 0.5 to 5 mg/kg body weight. Only fish weighing 1.2 kg underwent spermatogenesis. Milt was expressed from both control and steroid-injected fish six months after initiation of treatment. MT at 5 mg/kg body wt. stimulated active spermatogenesis after three and six months of treatment. Gonad weight and gonadosomatic index decreased.

- **Induced sex control in juvenile grouper, *Epinephelus* sp.**

Preliminary histological observations of the gonads indicated no significant differences between mibolerone-fed and control fish.

- **Development of practical diets for grouper larvae.**

Five types of artificial feeds containing white fish meal, mysid meal, squid meal, squid liver meal, soybean meal, fermented soybean meal, wheat flour, soybean oil, and vitamin powder were tested on grouper fry (3.8-5.1 cm). Diets with 30% soybean meal, 25% squid meal, 25% squid liver meal produced fry with the highest survival rate and maximum increase in body weight.

- **Identification of bacterial diseases affecting groupers, *Epinephelus* spp.**

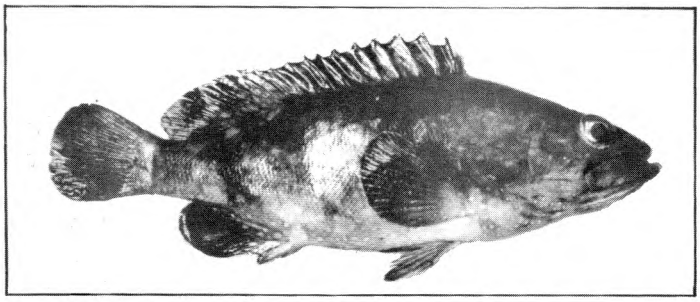
Two phenotypic groups of *Vibrio* were isolated from *Epinephelus malabaricus* broodstock showing typical signs of bacterial infection. Infected fish responded well to treatment with oxytetracycline-HCl administered via injection through the epaxial muscles at 25 mg/kg fish body weight for 5 consecutive days.

Cases of vibriosis occurred among cage- and tank-held grouper broodstock and juveniles. A sucrose-fermenting species of *Vibrio* was tested for its pathogenicity on healthy grouper fry (2 g). Most of the fish challenged by injection and a combination of injury and exposure to the bacteria died within two days. Among uninjured fish,

mortalities were observed only in groups continuously exposed to the bacteria for 96 hours.

***In progress*:**

- Development of grouper broodstock in floating net cages.
- Effects of dietary protein sources in grouper cultured in floating net cages.



Grouper (*Epinephelus malabaricus*) with vibriosis. Infected portions become necrotic, turn whitish, and the scales fall off.

Mullet *(Mugil cephalus)*

- Mullet broodstock development for fish propagation.

Rabbitfish *(Siganus guttatus)*

- **Application of thyroxine (T_4) to female *Siganus guttatus* broodstock and its effect on larval survival.**

Plasma thyroxine levels of thyroxine-injected spawners increased starting at 6 h post-injection, peaked at 24 h and declined at 48 h post-injection. Levels in control fish were consistently lower than in hormone-injected fish.

- **Weaning of rabbitfish (*Siganus guttatus*) to artificial diets with different protein-to-energy ratios.**

Comparisons were made on the growth, survival, and percentage metamorphosis of siganid larvae fed artificial diets with 15, 25, 35, 45, and 55% protein content. The diet with 35% protein gave optimal specific growth rate of the larvae. However, survival rates in all treatments were low (19-44%) compared to *Artemia*-fed larvae.

Milkfish *(Chanos chanos)*

- **The influence of LHRHa, 17α-methyltestosterone and thyroxine on off-season gonadal maturation and spawning of tank-reared milkfish (*Chanos chanos*).**

Groups of 19-20 6-year old milkfish were implanted with the hormones oil-based 17α-methyltestosterone (MT, 250 µg/fish in silastic capsule), LHRHa (200µg/fish), and triiodothyronine (T_3, 3 mg/fish) in cholesterol pellet to determine whether T_3 alone or in combination with MT+LHRHa would enhance sexual maturation of tank-reared milkfish. Controls were implanted with oil in silastic capsule (SC, N=10) or cholesterol pellets (CP, N=10). MT was implanted bimonthly, whereas LHRHa and T_3 were implanted monthly. Maturing females were obtained in February from MT+T_3, T_3 and CP one month after implantation. Percentage of maturing and mature fish increased in April in all groups. Cumulative percent maturation in May was highest in the control with silastic capsules (90%) and lowest in the control with cholesterol pellets (10%). Maturation rate of hormone-treated fish ranged from 25 to 50%.

- **Isolation and characterization of a female-specific plasma protein (vitellogenin) in milkfish, *Chanos chanos* Forsskal.**

Fractionation of plasma from estrogen-treated male and female adult milkfish in an Ultragel AcA 34 column showed a single major peak representing a protein with a molecular weight of around 400 kDa. Peak levels of alkali-labile phosphorus in fractionated plasma samples also coincided with the major protein peak. A small peak in the elution profile of plasma from untreated male and female milkfish coinciding with a 66 kDa protein had no detectable levels of alkali-labile P.

- **National Bangus Breeding Program (NBBP).**

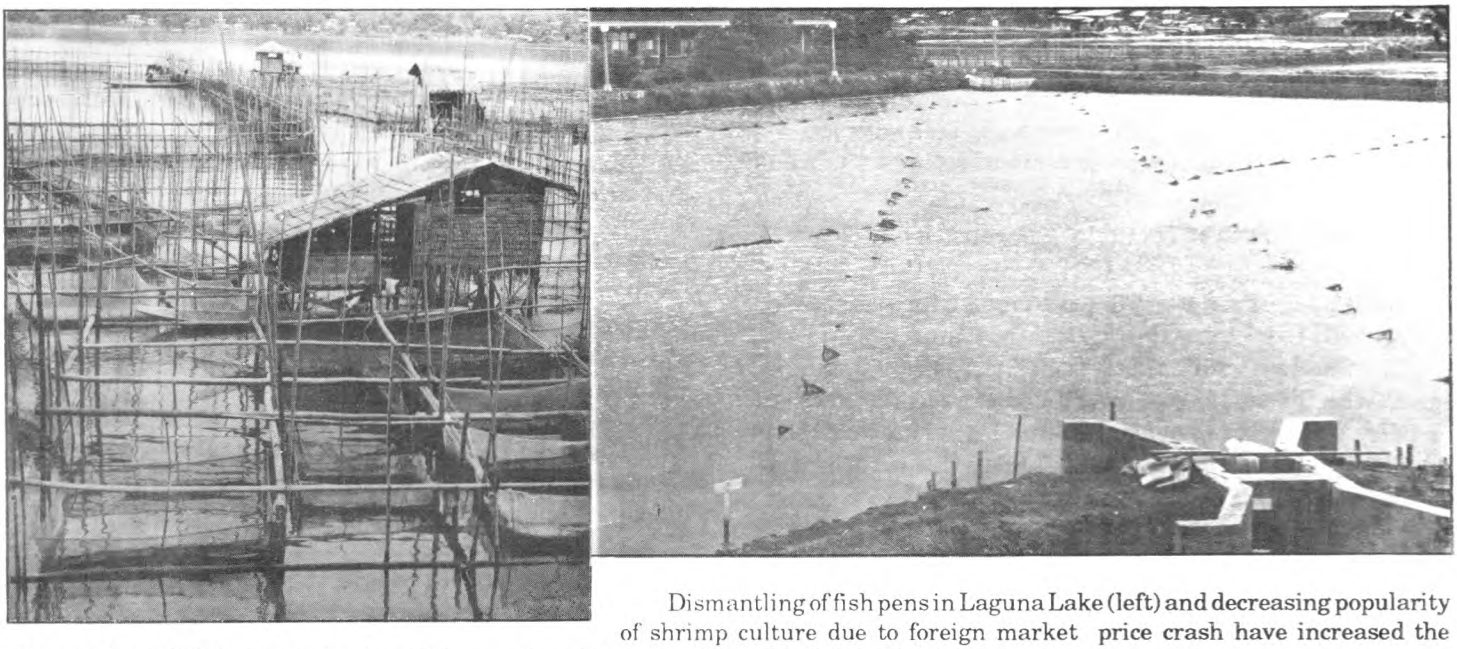
Natural spawning of captive milkfish broodstock in floating cages was reported early this year at all IDRC-assisted project sites (Regions I, III, VII, XI). However, the number of eggs collected were very low. Hatchery-reared milkfish fry were not produced.

Maintenance of captive juveniles and subadult stocks in brackishwater ponds or in floating net cages at other project sites is in progress.

- **Alternative feeding and rearing schemes in the larval rearing of milkfish.**

Preliminary trials were done to compare flow-through (30% and 100% turnover rates) and static systems (control) of water management for rearing milkfish larvae. Larval stocking density in flow-through tanks was 90 larvae/l, and in control tanks, 30 larvae/l. *Brachionus plicatilis* was maintained at a density of 10

National Bangus Breeding Program, 1989: captive broodstocks in floating cages spawned naturally at all project sites (Regions I, III, VII, XI). Right (Pangasinan), fish is netted to be checked for sexual maturation. ➡



Dismantling of fish pens in Laguna Lake (left) and decreasing popularity of shrimp culture due to foreign market price crash have increased the demand for milkfish, but technological innovations in pond culture of milkfish (right) are needed.

individuals/ml from day 3 to 9 and at 20 individuals from day 10 to 16. *Artemia* was fed from day 14 to 21 at 1 individual/ml. Heavy mortality occurred beginning day 3 in flow-through tanks, but the surviving larvae were more robust than those in control tanks.

•Socioeconomic analysis of the National Bangus Breeding Program (NBBP).

Economic indicators such as internal-rate-of-return and net-present-value showed negative figures up to the 15th year of an integrated milkfish broodstock and hatchery operation. Starting on the 16th year, however, there was an upward trend in the figures obtained. Thus, it will take more than 15 years for an integrated milkfish broodstock and hatchery operation to become profitable.

•Supplemental feeding of milkfish juveniles reared in modular ponds.

Two experiments were conducted to determine the effect of supplemental feeding on milkfish juveniles reared in modular ponds for 3 months. Fish were fed with supplemental diet on the last month of the culture period (T 1) or only with natural food in the pond (T 2). Yields (kg/ha) in T1 and T2 were 611 and 338 respectively in Expt. I and 107 and 110 respectively in Expt. II. Survival rates were 96 and 53% in T1 fish in Expt. I and 53 and 63% in T2 fish in Expt. II. In both experiments, carcass protein were 66 and 62% in T1 fish and 72 and 69% in T2 fish; crude fat, 19.2 and 18.7% for T1 fish and 10.0 and 14.7% for T2 fish. Fatty acid profile of T1 fish resembled that of the diet. Of 105 respondents in a palatability test, 55% preferred T1 fish, 24% chose T2 fish, and 21% had no preference.

•Effects of dietary fiber on growth and production of milkfish (*Chanos chanos*) in brackishwater ponds.

After two months of culture, average body weight of fish (48 g) fed diets with or without rice straw compost were not significantly different. Replacement of up to 75% diet with the compost supported optimum growth rate of milkfish at a standing crop of 336 kg/ha.

•Prevention of *Aeromonas hydrophila* infection among *Chanos chanos* (Forsskal) by vaccination.

Five strains of *Aeromonas hydrophila* were isolated from milkfish fingerlings. These were pathogenic to scaled fingerlings. Flagellar and somatic antigens raised in rabbits against a pool of the five strains were

tested on fingerlings by injection or immersion technique. Vaccinated milkfish were challenged with live *A. hydrophila* but results were inconclusive.

Tilapia (*Oreochromis* spp.)

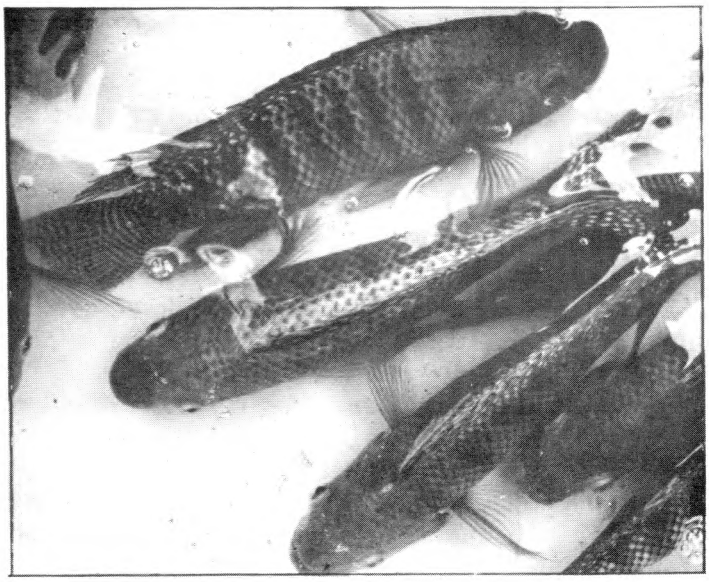
•Development of a high-yield red tilapia strain through introgressive hybridization.

Twelve families have been successfully spawned out of the 15 single-pair matings between *O.niloticus* females from NIFI (National Inland Fisheries Institute, Thailand) and red tilapia males. After five months, fry production was 106-603 and survival rate, 0-73%. Only three families produced normal colored (grey) offsprings.

•Growth, feed utilization, and body composition of young red tilapia given diets with various protein and energy levels.

Red tilapia fry (0.160 g mean weight) were fed diets containing 25, 30, 35 and 40% protein and protein energy ratios (P/E) of 111, 100 and 80 mg protein/Kcal at each protein level. At P/E 111 mg/Kcal, mean body weight increased with increasing protein level. At lower P/E ratios, body weights increased initially and then decreased with increasing dietary protein. Feed conversion efficiency (FCE) and protein efficiency ratio (PER) increased as P/E ratio decreased from 110 to 80 mg protein/Kcal at 25 and 30% protein. There was no trend in the changes of FCE or PER at the other protein levels.

• Development of salinity-tolerant strains/hybrids of *Oreochromis niloticus* for brackishwater culture. II. Growth performance of *O. niloticus, O. mossambicus,* and their F_1 hybrids at various salinities.



Although *Oreochromis niloticus, O. mossambicus,* and their F_1 hybrids can be acclimated and grown at various salinities, optimum ranges for their good growth and survival varied greatly. The salinity ranges for good growth of *O.mossambicus, O.niloticus,* and their F_1 hybrids were 15-32 ppt, 0-10 ppt, and 15-32 ppt, respectively. Salinity of up to 22 ppt had no significant effect on survival of all test strains; however, at 25-32 ppt, survival of *O.niloticus* was significantly lower than for *O. mossambicus* and their F_1 hybrids.

•Changes in plasma osmolality and chloride concentration during abrupt transfer and acclimation of tilapia strains to test salinities.

Oreochromis mossambicus, O.niloticus, and their F_1 hybrids with mean weight of 25 g can tolerate abrupt transfer from freshwater to 15 ppt. Abrupt transfer to 32 ppt resulted in mass mortality of *O.niloticus* and F_1 hybrids in 6 and 36-54 h, respectively. *O.mossambicus* can tolerate abrupt transfer to 32 ppt.

•Development of genetic evaluation and selection criteria for tilapia broodstock. I. Effect of crowding on survival and growth of strains of *Oreochromis niloticus* juveniles.

Growth rates of three Nile tilapia strains were slower in a crowded than in a less crowded condition. However, the Israel strain showed a significantly higher growth rate than did the strain from CLSU (Central Luzon State University, Nueva Ecija, Philippines).

•Development of genetic evaluation and selection criteria for tilapia broodstock. II. Effect of salinity stress on survival and growth of strains of *Oreochromis niloticus* juveniles.

Growth rates of three Nile tilapia strains were significantly higher in freshwater than in saltwater. Growth was similar for all strains in saline water.

•Development of genetic evaluation and selection criteria for tilapia broodstock. IV. Effect of restrictive and non-restrictive feeding on growth of strains of *Oreochromis niloticus.*

Although restrictive feeding retarded growth in all tilapia strains tested, the Israel strain appeared to perform better than either the NIFI (National Inland Fisheries Institute, Thailand) or the CLSU strains under a non-restricted or restricted feeding regime. Restricted feeding did not cause any discernible morphological abnormalities of the scales in all three strains tested.

Genetic evaluation, hybridization, selection, and feed utilization are emphasized in research on tilapia (*Oreochromis niloticus, O. mossambicus*).

***In progress*:**

- Growth performance evaluation of two *Oreochromis niloticus* strain in two lake environments.
- Effects of prolonged exposure to low level heavy metals on two Nile tilapia strains.

Catfish *(Clarias macrocephalus)*

- **Broodstock development and induced spawning of *Clarias macrocephalus* Gunther: Induced spawning using LHRHa and pimozide.**

Gravid catfish spawned 16-36 h after injection of LHRHa (0.005-0.10 µg/g body weight) combined with pimozide (1 µg/g). Fertilization, hatching and larval survival rates were higher among hormone-injected fish than in control. LHRHa (0.005-0.02 µg/g) and pimozide (0.5-2 µg/g) injected separately did not induce oocyte maturation and ovulation.

Plasma estradiol-17 ß (E_2) levels were higher in catfish which failed to spawn after a single injection of 0.02 µg/LHRHa/g than in the other hormone-injected groups. These peaked at 12 h before dropping to low levels at 36 h post-injection. No significant differences in levels of plasma testosterone and 17 α, 20 ß dihydroxy-4-pregnen-3-one were observed among treatment groups.

The catfish *Clarias macrocephalus* has become scarce. Culture attempts are made through broodstock development and spawning induction.

Bighead Carp *(Aristichthys nobilis)*

- **The effect of dietary carbohydrates, lipid and energy on growth, feed efficiency, protein utilization and tissue composition of bighead carp *(Aristichthys nobilis)* fry. (Thesis Research)**

Semi-purified diets containing three levels of lipid (4.26, 5.93, and 6.95%) and carbohydrate (42, 48, and 53%) to give different total dietary energy levels at two protein levels (28.9 and 37%) were fed to bighead carp fry (mean weight, 0.045-0.052 g). Growth of fry fed diets with higher protein level was significantly high. Increases in dietary lipid and carbohydrate depressed growth, and increases in protein and carbohydrate levels decreased protein efficiency ratio. Bighead carp fry performed better with diets containing 3,130 Kcal metabolizable energy (ME/kg) and protein energy ratio (P/E) of 92 mg/Kcal (for the 28.9% protein level) and 3,470 Kcal ME/kg and P/E ratio of 107 mg/Kcal (for the 37% protein level). Tissue lipid level increased with increasing dietary lipid and was inversely related to tissue protein, moisture, and ash.

***In progress*:**

- The influence of commonly used induced spawning agents on egg fertilization and hatching and larval survival in bighead carp, *Aristichthys nobilis.*

Giant Tiger Prawn *(Penaeus monodon)*

- **Effects of ß-ecdysone on ovarian maturation and rematuration of *Penaeus monodon* Fabricius.**

Gonadosomatic and ovary indices but not hepatosomatic index of wild broodstock at different ovarian maturation stages were significantly different. Partially purified vitellin had four major subunits with molecular weights of 150, 92, and 61 kDa, whereas lipovitellin had a molecular weight of 410-500 kDa. ß-ecdysone at 50 mg/g body weight significantly increased vitellogenin levels after 48 h in the intermolt and early premolt stages but the ovary was reabsorbed in late premolt stage.

- **Hormonal changes during vitellogenesis in *Penaeus monodon.***

Pond-reared *Penaeus monodon* broodstock at an early maturing stage had no detectable level of vitellogenin in the hemolymph. Preliminary immunological tests indicated that the ovary is the major site of vitellogenin synthesis.

•Verification studies on SEAFDEC-developed hatchery technology for *Penaeus monodon*.

Survival rate (17-18%) and growth rate (12 days to postlarval stage) were similar in larvae fed a SEAFDEC-formulated carageenan-microbound diet and a commercial larval food (BP Nippai). Larvae reared on natural food alone had significantly lower survival and growth rates.

•Evaluation of supplementary diets on growth, survival and production of *Penaeus monodon* in ponds.

Cassava or corn in combination with golden snails yielded the highest mean body weights of 40.8 and 35.5 g and highest harvests of 13.8 and 13.5 kg/500m^2, respectively. Survival ranged from 88.2 to 98.9%.

•Effect of processed feed as a supplemental diet in *Penaeus monodon* modified extensive culture.

Diets with and without vitamin supplementation given starting on the 45th day of culture increased average body weight (ABW) of *P.monodon* to 20.3 and 18.8 g respectively after 120 days culture period. Shrimps without the diet supplementation (control) had low ABW (9.4 g).

•The effect of dietary astaxanthin and vitamin A supplementation on reproductive performance of *Penaeus monodon* broodstock. (Thesis Research)

The supplementation of either or both astaxanthin and vitamin A in *Penaeus monodon* broodstock diet showed that astaxanthin significantly improved gonad index ($P<0.05$), but its influence on fecundity and hatching rate is not clear. Diet supplementation caused weakening, poor feeding and high mortality, the most severe effect being with the supplementation of both astaxanthin and vitamin A. The results suggests involvement of dietary astaxanthin in gonadal development.

•The use of *Artemia* biomass as a dietary ingredient in formulated diets for *Penaeus monodon* postlarvae.

Postlarvae (P_{1-30}) fed diets with *Artemia* meal processed by various methods (sun-, spray-, freeze-drying) had similar growth rates, stress resistance and survival rates. However, sun-drying was more appropriate for local conditions as it eliminates the need for expensive equipment and simplifies feeding.

•Development of microbiological processing techniques for agricultural products and wastes as partial replacement for ingredients in compounded feeds for prawn.

Feeds make up at least half of shrimp culture cost. Cheaper practical diets with local ingredients are tested at the Department.

Thirty types of microbound feeds composed of various combinations of processed white fish meal, mysid meal, squid meal, squid liver meal, mussel meal, soybean meal, skim milk, wheat flour, soybean oil and cod liver oil were prepared and tested on *P. monodon* larvae. Microbound feed with 60% fermented soybean meal produced survival rate of 40% from zoea$_1$ to early post-larval stages. Results suggest that processed local products may be effectively utilized as ingredients for larval feeds.

•The effect of dehulling on digestibility of various leguminous seeds as protein sources for tiger prawn (*Penaeus monodon*) juveniles.

After 30 days of culture, prawn juveniles fed dehulled cowpea and rice bean had higher survival rates of 55% and 67% respectively compared to animals fed reference protein (soybean) (47.5%), whole cowpea (35.5%), and whole rice bean (45%).

•Vibriosis of *Penaeus monodon* in hatchery: Epidemiology and control.

Spawners are carriers of luminous vibriosis, hence are primary sources of the *Vibrio* inoculum. The inoculum potential is discharged in the spawning water previously treated with chlorine, suggesting its alimentary or ovarian origin, or both; its net effect includes selective *Vibrio* repopulation of treated water in the hatchery tank following stocking of larvae from such spawners.

The seawater supply system despite its built-in filter is likewise a source of inoculum, but infection tests in aquaria were negative when stocking was with nauplii hatched from surface-disinfected eggs and feeding was with only cell suspension of laboratory-reared *Saccharomyces cerevisiae*, a yeast. Conversely, *Vibrio*-free nauplii became diseased when stocked in chlorine- and UV-

treated water but given *Artemia* and *Chaetoceros* suspensions, indicating that both feeds are disease carriers.

The *Vibrio* bacterium is also pathogenic to *P. japonicus*. Host range study is underway to include *P. merguiensis, P. indicus, Artemia salina* and planktonic algae used as traditional feed in hatcheries.

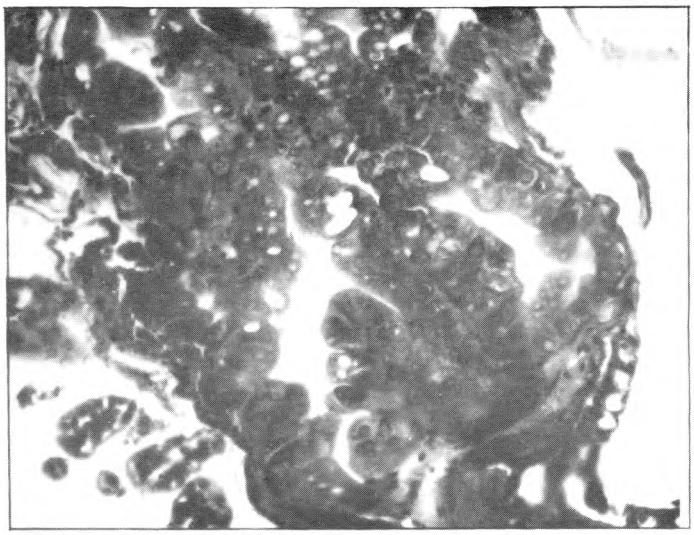
•Pathogenicity of luminous bacteria on larvae and postlarvae of *Penaeus monodon*.

Larval mortalities associated with luminescence occurred in epizootic proportions in black tiger prawn (*Penaeus monodon*) hatcheries in Panay Island, Philippines. Luminescent vibrios, identified as *Vibrio harveyi* and *V. splendidus*, were isolated from infected larvae but not from uninfected ones. These bacteria were also recovered readily from seawater samples from nearshore areas, the main source of hatchery rearing water. Thus, it is possible that the nearshore seawater is the source of infection.

Pathogenicity tests with *V. harveyi* resulted in significant mortalities of larvae and postlarvae of *P. monodon* within 48 h of challenge. Scanning electron microscopy showed bacterial colonization of the feeding apparatus and oral cavity of the larvae, suggesting an oral route of entry for the initiation of infection.

•Detection of *Penaeus monodon* baculovirus (MBV) in hatchery systems.

MBV occlusion bodies were first observed in the hepatopancreas of a spawner sampled in August 1989. From hatchery runs at SEAFDEC, MBV was detected in postlarvae 9 from batch ran 23 August-15 September 1989, and in postlarvae 4 from batch ran 30 August-10 October 1989. Older postlarvae from these batches were positive for MBV. Of the 30 batches of larvae and postlarvae from 23 private hatcheries in Aklan, Iloilo, Capiz and Negros Oriental, 13 samples (43.3%) from 12 hatcheries (52.2%) were positive for MBV, with the earliest affected stage being PL_3.



Occlusion bodies of monodon baculovirus in hepatopancreas of *Penaeus monodon*. The disease (MBV) contributed to the fall of the shrimp industry in Taiwan; it is now present in the Philippines.

•Antibiotic treatments for *Penaeus monodon* through the food chain.

Penaeus monodon nauplius VI to postlarva 1 given the microparticulate diet Precal without antibiotics, Precal with 10% chloramphenicol base and Precal with 10% furazolidone had higher survival rates (40.25-44.77%) than those given Precal with 10% chloramphenicol palmitate, *Chaetoceros calcitrans* alone or Precal alone (10-17%). Chloramphenicol base in the diet induced abnormal development like bent rostrum, while furazolidone reduced bacterial counts in the larvae (10^2 cfu/ml) but not in the water (10^3 cfu/ml).

•Effect of water treatment using chlorine on the microbial load of seawater particularly on luminous bacterial populations.

Chlorination of sand-filtered and microfiltered seawater with 5-30 ppm available chlorine for 12-24 h significantly reduced (by 99+%) the initial total plate counts (TPCs) and luminous bacterial counts (LBCs) from 10^5 cfu/ml and 10^2-10^3 cfu/ml, respectively, to 10^1 cfu/ml and 0 cfu/ml, respectively. Successive samplings 2, 4, 6, 12 and 24 h after neutralization showed that the TPCs of treated water steadily increased as the neutralization period became longer, reaching levels equal to or higher than that of untreated water after 24 h. Luminous bacteria reappeared 6-24 h after neutralization. Results suggest that chlorine only exerts bacteriostatic effects at 5-30 ppm and that treated water must be used within 6 h after neutralization when bacterial load is minimal at 10^2 cfu/ml or less.

•Investigations on the vertical and horizontal transfer mechanisms of the luminescent bacterium, *Vibrio harveyi*, affecting *Penaeus monodon* larvae.

Luminous bacteria were isolated in large numbers from the intestinal contents of Stage IV wild-caught *P. monodon* spawners, but not from the mature ovaries with ripe eggs. Smaller numbers of the same bacteria were also recovered from plated samples of exoskeletal materials although under the scanning electron microscope no significant attached populations were seen.

***In progress*:**

•Evaluation of suitability of different external tags for *Penaeus monodon* juveniles (Artificial restocking of

prawns in Southern Panay).

- Effect of stocking density and diet on *Penaeus monodon* broodstock production in ponds.
- The effect of diet on the growth, survival, and gonadal development of ablated and unablated pond-reared *Penaeus monodon* in ponds.
- *Penaeus monodon* culture using sand as substrate with free-flowing tidal water.
- Evaluation of unprocessed feeds in semi-intensive *Penaeus monodon* (Fabricius) pond culture.
- Natural diet of *Penaeus monodon* Fabricius of various size classes in pond.

White Shrimps (*Penaeus indicus* and *P. merguiensis*)

•Changes in hemolymph and tissue proteins at different stages of gonad development in *Penaeus indicus*.

Levels of vitellogenin in the hemolymph of unablated *Penaeus indicus* gradually increased during sexual maturation, with peak levels detected in females with ovaries at the cortical rod stage (GSI: 1.55-3.76%). Although present in small quantities among unablated, spent female prawns, hemolymph vitellogenin was not detectable among spent, ablated females (GSI: 0.85-3.45%).

•Determination of optimum larval rearing conditions for white shrimps (*Penaeus indicus* and *P. merguiensis*) with reference to salinity levels, feeds and feeding.

Larval [zoea 1 to postlarva 1 (PL_1)] and postlarval (PL_{1-20}) rearing of *Penaeus indicus* and *P. merguiensis* in a hatchery using commercial artificial diet has been conducted. However, rearing with live feed (*Tetraselmis, Artemia*) gave survival rates of 49% and 57% for *P. indicus* and *P. merguiensis,* respectively.

• Ingestion rates and food selectivity of *Penaeus merguiensis* larvae.

Protozoea of *Penaeus merguiensis* did not preferably select any of the algae offered as food (*Tetraselmis, Chaetoceros calcitrans, Skeletonema costatum, Isochrysis*). However, when any of these algae was offered in combination with *Artemia,* the ingestion of *Artemia* by protozoea 3 and early mysis larvae but not by mysis 3 was influenced by the concentration of algae.

•The effect of dietary lipid sources on reproductive performance and tissue composition of *Penaeus indicus* broodstock.

Broodstock were fed diets supplemented with cod-liver oil (Diet A), soybean oil (Diet B) or their 1:1 combination (Diet C), with frozen squid diet as control. Diet C was best in terms of number of spawning, eggs and nauplii production, percentage of nauplii that metamorphosed into zoea, and broodstock survival. The control diet was the poorest.

•Development and evaluation of larval diets for *Penaeus indicus* and *P. merguiensis*.

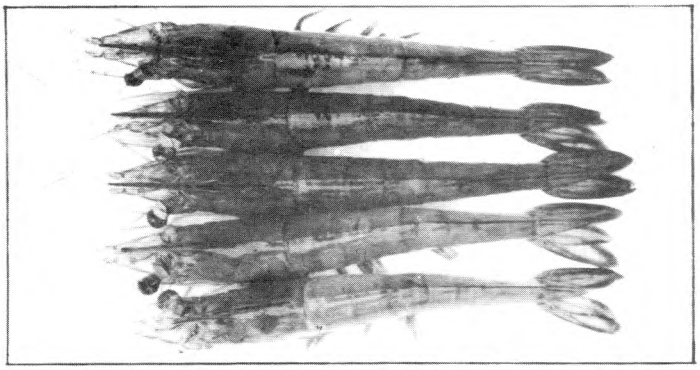
Artificial diets C-MBD, RK_1, and RK_2 in combination with natural food were fed to *P. indicus* larvae reared at two temperature ranges (29-30°C and 26-28°C). The rearing period from Z_1 to PL_1 varied from 12 to 14 days. Survival rate was almost doubled (34%) using a combination of C-MBD and *Skeletonema* with temperature maintained at 29-30°C.

•Evaluation of plant proteins as partial replacement for animal protein in diets of *Penaeus indicus* juveniles.

Postlarvae reared for 42 days on diets with 10-30% of fish meal replaced with 20% coconut yeast or 30% soybean meal had higher weight gain (172%) than those fed fresh squid, basal diet, or diets with 10-30% of fish meal replaced with 10% *Torula* yeast or 20% soybean meal. However, they had lower survival rate than those fed fresh squid or basal diet.

In progress:

- Assessment of unprocessed feeds for *Penaeus indicus* culture in ponds.

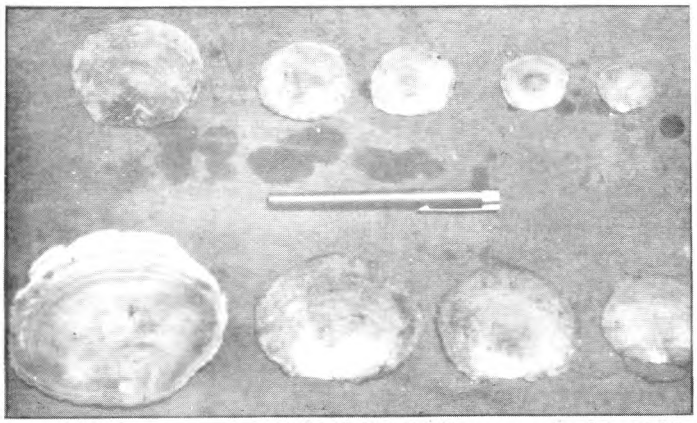


White shrimps (*putian*) are more salt-tolerant than the tiger prawn, hence their culture does not conflict with human need for freshwater.

Molluscs (*Crassostrea, Placuna*)

•Preliminary study on induced triploidy in the Philippine oyster, *Crassostrea iredalei,* using temperature shock and cytochalasin-ß.

Twenty-four hours after the application of ther-



Mollusc research at SEAFDEC/AQD was revived in 1989. The window-pane oyster (*Placuna placenta*) (spats shown above) is a priority species because of its importance to the shell industry.

mal shock of 33, 37, 41 and 45°C for 15 minutes on fertilized eggs (40 min post-fertilization), survival rates were 10.2, 3.8, 1.2 and 0.3%, respectively. Survival rate of eggs at ambient temperature was 6.4%.

All larvae survived 24 hours after administration of 1 mg/l cytochalasin-ß for 15 minutes on newly fertilized eggs 15, 30, or 40 minutes post-fertilization. Attempt to prepare chromosome spreads on 2-, 24-, and 48-hour old larvae was not successful.

•Induced spawning, larval, and post-larval rearing of window-pane oyster, *Placuna placenta*.

Induced spawning of adult *Placuna placenta* (90-100 mm) by water flow manipulation, addition of gametes, thermal shock, cold shock, or addition of NaOH was unsuccessful. Histological preparations of gonad showed that 40% of the stock were partially spent, 40% spent, and 20% early recovering.

Gonad color as basis for sexual dimorphism was confirmed (dirty-yellow, male; orange-yellow, female).

***In progress*:**

- Algal food preference and its effect on growth of *Placuna placenta* larvae and spat.

Seaweeds (*Gracilaria* spp.)

•Production of *Gracilaria* spp. using different culture systems.

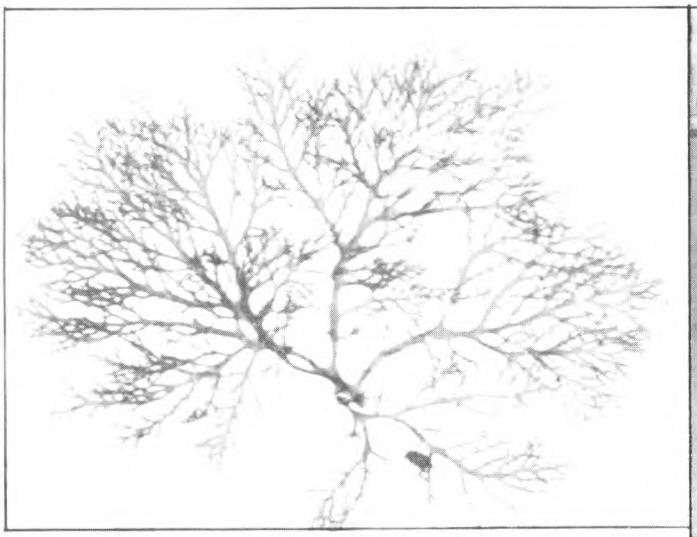
Bimonthly sampling from February to December 1989 showed similar specific growth rates of *Gracilaria* sp. 2 broadcasted at 200, 250, 300 and 350 g/cage in sea cages (1.9±0.04%/day) and in cages in ponds (1.45±0.06%/day).

•Inventory and assessment of biomass production of *Gracilaria* spp. in Panay Island.

The macrobenthic algae in Panay Island were inventoried. The Chlorophyceae included 34 species belonging to 18 genera, 11 families, and 5 orders; Phaeophyceae with 19 species, 9 genera, 5 families, and 4 orders; and Rhodophyceae with 49 species, 30 genera, 16 families, and 6 orders. Ten species of Chlorophyceae, 4 of Phaeophyceae, and 16 of Rhodophyceae are new records for Panay Island.

•Characterization of agar from different species of *Gracilaria*.

Gracilaria blodgettii from Guimbal, Iloilo, *G.*



The marine macrobenthic algae of Panay Island in Central Philippines (left) are field-surveyed, collected, and preserved (right), with emphasis on *Gracilaria*, the source of agar of commerce.

coronopifolia from Buenavista, Guimaras, and *Gracilaria* sp. 2 from Leganes, Iloilo gave agar yields of 24.38, 16.73 and 32.40%, respectively. Agar from *G. blodgettii* gave the highest gel strength (558 g-cm^{-2}); that of *G. coronopifolia* gave the lowest (170 g-cm^{-2}). Agar gelling and melting temperatures for *G. blodgettii, G. coronopifolia,* and *Gracilaria* sp. 2 were 38.5, 39.0 and 40°C, and 85.0, 83.0 and 80.5°C, respectively. Agar viscocity for *G. blodgettii* was 18 cps and that for *Gracilaria* sp. 2 was 7.5 cps. Moisture and ash contents for *G. blodgettii* and *Gracilaria* sp. 2 were 15.2 and 8.04%, and 4.32 and 4.98%, respectively.

•Preliminary studies on field cultivation of *Gracilaria* utilizing hatchery-produced sporelings and vegetative fragments.

Preliminary field culture of *Gracilaria* using vegetative fragments inserted between braids of ropes suspended vertically inside a floating cage was undertaken to assess its daily growth rate and monthly yield as influenced by three different spacing intervals.

Daily growth rate of cuttings grown at 10-cm interval ranged from 0.63 to 7.23% with yields of 11.13 to 414.67 g m^{-1} line^{-1} those at 15 cm from 1.40 to 9.13% with yields of 17.83 to 501.67 g m^{-1} line^{-1}, and at 20 cm from 1.67 to 10.47% and with yields of 20.27 to 378.50 g m^{-1} line^{-1}. Both growth and yield were minimum in December at all spacing intervals but maximum in April at 10 and 15 cm and in February at 20 cm.

Results of the analysis of variance (ANOVA) showed a nonsignificant interaction between spacing interval and culture month on daily growth rate and monthly yield of *Gracilaria*. This indicates that the effect of spacing interval on the daily growth rate and monthly yield was not significantly influenced by the culture month; likewise the effect of culture month did not differ significantly with the intervals used. The main effects, however, of spacing interval and culture month on daily growth rate were significant. Yield was significantly affected by the culture month but not by spacing interval.

•Polyculture of *Gracilaria* (Gigartinales, Rhodophyceae) and *Lates calcarifer* Bloch in floating net cages.

Decreased growth rate and production pattern were observed in October and November for *Gracilaria* plants grown at increasing depth levels (25, 50, and 100 cm below water surface). Total loss of plants occurred in December due to strong northeast monsoon wind.

•Management of a *Gracilaria* (Gigartinales, Rhodophyceae) bed at Ivisan, Capiz.

Gracilaria plants harvested at 50% of the total weight gave the highest percentage recovery in the succeeding harvest.

Others

•Feeding of different nutritional quality *Artemia* to finfish and prawn larvae.

Prolonged feeding of *Siganus guttatus* with enriched *Artemia* resulted in lower growth rate.

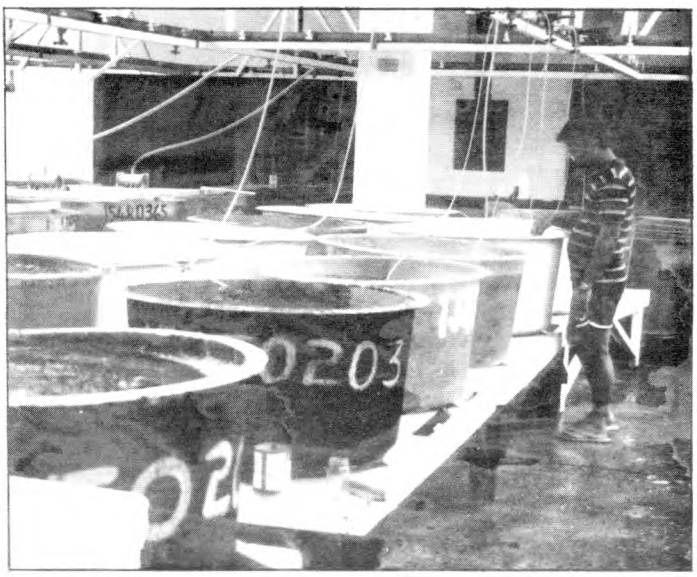
•Intensive biomass culture of *Artemia* in air-water lift raceway and flow-through systems.

Production yields of 3-8 kg *Artemia*/ton were obtained from a semi-flow-through culture system. Depending on the stocking density level of *Artemia* (2-8 million/ton), a flow rate of 50 l/h during days 1 to 4 of culture and 150 l/h from the 5th to the 12th day resulted in high survival rates (70-80%). A constant feeding level of 140 g ricebran/ton/day during the first 3 days of culture followed by twice daily feeding starting on the 4th day of culture also resulted in high biomass production yields and survival rate.

•Optimal growth conditions of the marine diatoms *Skeletonema costatum* and *Chaetoceros calcitrans* in large outdoor continuous culture.

Chaetoceros calcitrans had an average specific growth rate of 0.53 division/day during four days of batch culture in F-medium containing nitrate (25 to 883 *u*M). Flow rates of 24-88 ml/min provide water replacement rates of 35-100% of culture volume/day.

•Economic analysis of algae production (*Chaetoceros calcitrans* and *Skeletonema costatum*) for



Mass culture of larval food algae, *Artemia* and *Brachionus* is an integral part of finfish and shrimp hatchery operations.

prawn hatcheries.

The cost of producing *Skeletonema costatum* and *Chaetoceros calcitrans* is ₱36.69 per liter. This includes direct costs such as F-medium, algal starter, labor, gas and electricity.

•Biotechnology in aquaculture: Use of microbes in larval rearing of prawns and finfishes.

Saccharomyces cerevisiae and a marine yeast were brought into axenic culture and cell suspensions of both were used in *in vitro* propagation of the freshwater *Moina,* and the marine rotifer *Brachionus* and ciliate *Euplotes*; the marine yeast was used also in the maintenance of *Placuna* broodstock. Clonal populations of *Moina* were produced with live cells of *S. cerevisiae* and spores of 11 filamentous fungi isolated from seagrass.

The life cycle of *Moina* is under study; the number of filial progenies averages 22-28 per individual with the new technique, as against only 6-8 with the old method using blended baker's yeast pellets plus algal plankton.

Siganus guttatus (25-day old) in aquaria were fed at 10% fish body weight for 7 days with natural food (*Artemia, Ulva, Gracilaria, Sargassum, Artemia* plus *Ulva, Artemia* plus *Gracilaria, Artemia* plus *Sargassum*). Survival was highest at 47% with *Artemia, Artemia* plus *Gracilaria* and *Artemia* plus *Sargassum*, and lowest at 6% with all others.

•Regional research on the relationship between the ulcerative syndrome in fish and the environment.

Fish affected with ulcerative syndrome were observed in Laguna Lake beginning in mid-November. The metals Cu, Fe and Zn were detected in the water samples from the lake's East Bay; these plus Hg were detected also from West Bay waters. The metals were also present in fish samples from both bays. Carbamates and organophosphates were not detected.

•Histopathology of epizootic ulcerative syndrome in some freshwater fishes of Laguna de Bay, Philippines. (Thesis Research)

Sampling of catfish from West Bay of Laguna de Bay for histological and hematological profile of naturally EUS-infected fish was continued in late November.

•Aquatic fungi in the etiology of epizootic ulcerative syndrome (EUS).

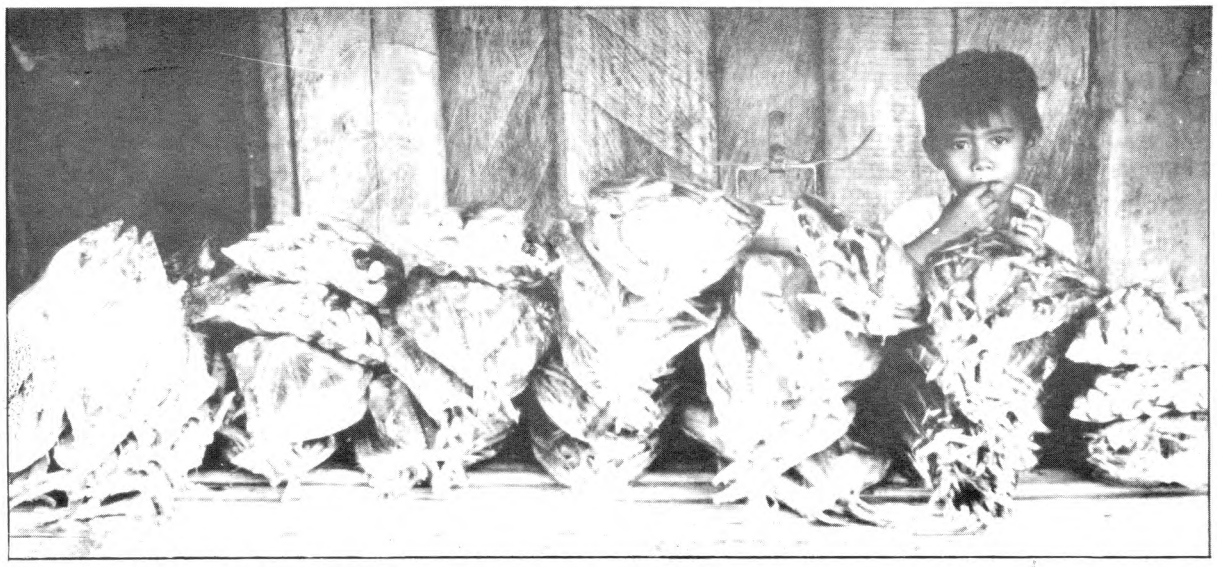
Achlya (?) *proliferoides* was isolated from EUS-afflicted snakeheads in Laguna Lake. This was brought into axenic culture and will be tested for pathogenicity.

•Viral and bacterial etiology of the epizootic ulcerative syndrome (EUS).

Attempts are being made to establish cell lines from various tissues of snakehead and catfish. Initial sampling of EUS-affected fishes is also being done for bacterial and viral isolations.

***In progress*:**

•Use of rice straw (*dayami*) in the eradication of snails in brackishwater ponds.



"The well-being of the small farmers... is a challenge to the economic and social ingenuity of those who have been given the gift of scientific training. It is a gift that can be repaid only in the measure to which it is applied to help the poorest to move upward from deprived lives." - *Dr. D.L. Umali*, National Scientist, Philippines.

Abstracts of Research Publications

•Agbayani RF, Baliao DD, Franco NM, Ticar RB, Guanzon NG. 1989. An economic analysis of the modular pond system in milkfish production in the Philippines. *Aquaculture* 83:249-259.

In 1980, the annual yield of milkfish ponds in The Philippines was 800 kg/ha while the potential yield is estimated to be 2000 kg/ha. The modular pond system analyzed in this study can largely close the gap between actual and potential yield through more efficient use of pond capacity to increase the number of croppings up to 7 times in 1 year. Pilot-scale production using the modular pond system was done at the Leganes Research Station (LRS) SEAFDEC, Iloilo, and at three cooperating commercial farms. Scale of operation ranged from 2.7 ha to 7.9 ha. From 2 to 7 production runs were recorded with per hectare outputs ranging from 278 kg to 341 kg per run. Input costs were based on actual figures and the ex-farm milkfish price as P21.00 (4 to 6 fish/kg). The average return on investment and payback period for all sites was 68.81% and 1.25 years, respectively.

•Aoki T, Hirono I, de Castro T, Kitao T. 1989. Rapid identification of *Vibrio anguillarum* by colony hybridization. *J. Appl. Ichthyol.* 5:67-73.

A 562 base pair fragment of DNA from a serotype A strain of *Vibrio anguillarum* was cloned into pUC9 and used as a hybridization probe for the rapid identification of *Vibrio anguillarum* by colony hybridization. The probe was tested on nine different fish pathogens, 15 *Vibrio* isolates, 2 organisms closely related to *Vibrio*, and 9 serotypes of *V. anguillarum*. The probe hybridized only with the DNA of *V.anguillarum* serotypes A and H. The sequence of the 562 nucleotides have been determined. This probe allows rapid, reliable, and specific detection of *V. anguillarum* in freshwater ayu, *Plecoglossus altivelis*.

•Apud FD. 1988. Prawn grow-out practices in the Philippines. *In: Biology and Culture of Penaeus monodon.* BRAIS State-of-the-Art Series No. 2; Aquaculture Department, Southeast Asian Fisheries Development Center; Tigbauan, Iloilo, Philippines; 89-118.

Prawn farming in the Philippines is generally classified into three: extensive, semi-intensive, and intensive (Apud et al 1983, Apud 1985). While intensive farming is gaining rapid development in marginal and elevated areas along the shoreline, extensive and semi-intensive farming is done mainly in former for milkfish culture areas.

Regardless of the type of farming being practiced, most farmers are usually confronted with the problem of standardizing their operation. Production can vary from one crop to another or from one pond to another and even from one individual, site, and/or facility to another. In effect, there is a need to standardize prawn farming practices for consistent reference. Presently, prawn farming is viewed more as an art rather than as exact science.

This paper deals mainly with the state of the art of prawn pond culture, specifically with pond management practices, including site suitability, engineering design, and harvest and post-harvest handling. For added insight, problems and prospects in the industry are briefly discussed with some recommendations.

Grow-out of *P. monodon*: stocking densities and projected yields per hectare per cropping (*After* Apud, *Biology and Culture of Penaeus monodon*, p. 98. 1988)

Density levels (pcs/ha)	Yield/ha/cropping (kg)
2000 - 7500	50 - 200
10 000 - 15 000	250 - 350
20 000 - 30 000	400 - 700
40 000 - 50 000	750 - 1200
60 000 - 80 000	1300 - 2500
100 000 - 120 000	2500 - 3500
150 000 - 250 000	4000 - 7000
300 000 - 400 000	7500 - 12 000

•Avila EM. 1989. Food consumption of sea perch, *Lates calcarifer*, in captivity. Huisman EA, Zonneveld N, Bouwans AHM, eds. *Aquaculture Research in Asia: Management Techniques and Nutrition: Proceedings of the Asian Seminar on Aquaculture* organized by IFS; 1988 November 14-18; Malang, Indonesia. Wageningen: Pudoc; 57-61.

Growth rate of seaperch (*Lates calcarifer*) will be studied in relation to fish size, water temperature, feed ration size, and feeding frequency.

Seaperch of different weight classes are held individually in conical tanks of 250 l each, which form part of a water recirculation system. Fish are fed by hand a commercially available pelleted feed containing 44% crude protein. Water temperature is maintained between narrow ranges and salinity amounts to 32 ppt. The

conical tanks allow for immediate collection of uneaten feed and thereby for determination of the actual feed intake.

These studies are being carried out in the conviction that they will provide important base-line data for the enhancement of seaperch culture.

•Ayson FG. 1989. The effect of stress on spawning of brood fish and survival of larvae of the rabbitfish, *Siganus guttatus* (Bloch). *Aquaculture* 80:241-246.

The effect of stress due to handling, and repeated sham and human chorionic gonadotropin (HCG) injections on spawning and survival were studied. Results showed that stress significantly enhanced spawning in captive females ($P<0.05$), but apparently has no significant effect on the survival of larvae. The results indicate that factors other than stress are responsible for the high variability in larval survival in the hatchery. In addition, the results clearly demonstrate the necessity of exogenous gonadotropin to ensure 100% monthly spawning of captive *S. guttatus* females.

•Baticados MCL. 1988. Diseases. *In: Biology and Culture of Penaeus monodon.* BRAIS State-of-the-Art Series No. 2; Aquaculture Department, Southeast Asian Fisheries Development Center; Tigbauan, Iloilo, Philippines; 139-178.

The great losses suffered by the industry due to diseases attest to the need to focus more attention on this aspect of aquaculture. Prawn diseases have been the subject of many reports from various culture facilities in the Philippines (Villaluz 1975, Gacutan 1979, Vicente et al 1979), Taiwan (Liao et al 1977), Thailand (Ruangpan 1982), and Mexico (Lightner et al 1984). Reviews of diseases causing significant losses in penaeid shrimp and prawn culture have been made by Lightner (1983, 1985) with special emphasis on more recent trends and developments. The present review deals specifically with diseases of the giant tiger prawn, *Penaeus monodon* Fabricius, including the diagnosis and pathology of disease or disease agents involved and their prevention and control.

•Baticados, MCL. 1988. Typical prawn diseases: causes, prevention and treatment. Chiu YN, Santos LM, Juliano RO, eds. *Technical Considerations for the Management and Operation of Intensive Prawn Farms;* 1987 November 16-20; Iloilo City, Philippines. Iloilo City: UP Aquaculture Society; 134-143.

Diseases of prawns in ponds are caused by microorganisms like viruses, bacteria, fungi and protozoans as well as factors such as nutritional deficiency, poor pond conditions and environmental pollutants. Most of these diseases may be controlled by environmental and dietary manipulation. Control of transfers or introduction of new prawn species may also reduce the risk of disease occurrence. Chemotherapy is considered only as a last resort in the control of diseases in prawn ponds. The basic features of prawn diseases with emphasis on causative agents and methods of prevention and treatment are discussed.

•Bautista MN, Millamena OM, Kanazawa A. 1989. Use of kappa-carrageenan microbound diet (C-MBD) for *Penaeus monodon* larvae. *Mar. Biol.* 103:169-174.

The performance of an artificial practical diet, kappa-carrageenan microbound diet (C-MBD) was assessed on *Penaeus monodon* larvae at the SEAFDEC Broodstock and Maturation Experimental Laboratory in March 1986. Shrimps were reared from $zoea_1$ to $post\text{-}larvae_1$ using five dietary treatments: (a) natural food-*Chaetoceros calcitrans* and *Artemia salina;* (b) C-MBD; (c) combination of natural food and C-MBD; (d) commercial diet (microencapsulated, MED); (e) combination of natural food and commercial diet. Results showed slow

Spawning success of *Siganus guttatus* subjected to three kinds of stress (*After* Ayson, *Aquaculture* 80:243. 1989)

Date	Control			Handled - no injection			Handled+sham injection			Handled+HCG injection		
	A	B	%	A	B	%	A	B	%	A	B	%
(1986)												
Dec.	3	1	33.3	3	2	66.6	3	3	100	3	3	100
(1987)												
Jan.	3	0	0	3	2	66.6	3	2	66.6	3	3	100
Feb.	3	0	0	3	2	66.6	3	1	33.3	3	3	100
March	3	0	0	3	2	66.6	3	0	0	3	3	100
All			8.3±8.3			66.6±0*			49.9±21.5			100±0*

A - number of females. B - number of females that spawned. *Significant compared to the control ($P<0.05$).

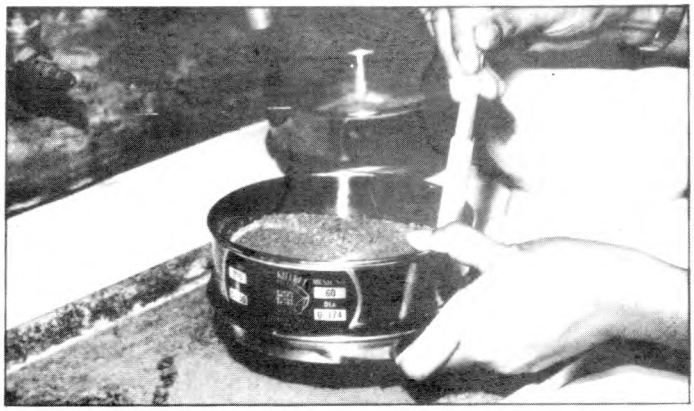
development with larvae fed the commercial diet. Feeding with C-MBD in combination with natural food resulted in the highest % survival among treatments (69.6), but this was not significantly different ($p>0.05$) from those obtained with larvae fed natural food alone, C-MBD alone or their combination. While mean values for survival of larvae fed the commercial diet, either alone or in combination, was significantly lower ($p<0.05$) than all other treatments, their mean growth indices were comparable with larvae fed C-MBD alone or in combination. The low levels of protein, lipid and essentially fatty acids (which are considered important nutrients during larval development) contained in the commercial diet may well justify the results on metamorphosis, survival and growth of the larvae fed this diet. The good performance of C-MBD in this experiment suggests that this kind of diet can be used as partial or total replacement to the traditional algal food.

•Benitez LV. 1989. Amino acid and fatty acid profiles in aquaculture nutrition studies. De Silva SS, ed. *Finfish Nutrition Research in Asia: Proceedings of the Third Asian Fish Nutrition Network Meeting; Asian Fish. Soc. Spec. Publ. 4;* 1988 June 6-10; Bangkok, Thailand. Manila, Philippines: Asian Fisheries Society; 23-35.

The amino acid profile is an important parameter in the evaluation of protein quality and in requirement studies. Amino acid profiles are usually determined in two steps: hydrolysis of the protein to constituent amino acids followed by quantitative analysis of the amino acids in the hydrolysate. The ten amino acids known to be essential in most animals have been found to be essential in all fish so far studied. The reference amino acid profiles used in the amino acid requirement studies of various fish species include that of whole chicken, egg, fish egg and fish muscle. The amino acid profile of fish muscle provides a useful first approximation of the amino acid requirement of the young, growing fish in which the greatest proportion of weight gain is in the form of muscle.

Fatty acid composition (% of weight) of *Penaeus monodon* larvae, live feed, and kappa-carrageenan microbound (C-MBD) and commercial (MED) diets (*After* Bautista et al., *Mar. Biol.* 103:172. 1989)

Fatty acid	Prawn larvae	*Chaetoceros calcitrans*	*Artemia*	C-MBD	Commercial diet (MED)
$C_{12:0}$	-	2.83	-	-	-
$C_{14:0}$	8.11	21.52	1.53	0.22	0.57
$C_{14:1}$	-	-	3.30	-	0.81
$C_{15:0}$	12.10	2.33	0.11	-	0.67
$C_{16:0}$	13.94	4.64	15.23	18.00	15.42
$C_{16:1\omega7}$	5.45	30.17	10.38	4.10	10.79
$C_{16:2\omega7}$	-	-	2.94	-	-
$C_{17:0}$	-	-	3.28	3.90	3.88
$C_{18:0}$	7.23	8.93	3.17	5.31	4.79
$C_{18:1\omega9}$	14.67	6.06	29.05	22.32	35.76
$C_{18:2\omega6}$	7.78	1.86	6.79	5.99	9.59
$C_{18:3\omega3}$	3.32	0.40	6.35	2.50	4.87
$C_{20:1\omega9}$	1.29	-	0.42	-	0.52
$C_{20:3\omega6}$	-	-	1.47	-	-
$C_{20:4\omega6}$	5.93	2.24	-	3.50	2.76
$C_{20:5\omega3}$	14.29	18.08	13.63	19.49	8.98
$C_{22:4\omega6}$	0.82	0.66	0.53	5.22	0.28
$C_{22:5\omega3}$	-	-	0.04	2.73	-
$C_{22:6\omega3}$	5.02	0.26	0.87	11.70	0.06



Quality (fatty acid, amino acid, vitamin, energ. ligestibility) is as important as quantity of components in feed formulations.

Fatty acids are important components of lipids. Determination of fatty acid profiles involve the extraction of total lipids with organic solvents and the transesterification of the lipid to form the fatty acid methyl esters which are then analyzed by gas chromatography. The fatty acid composition of fish is dependant on such factors as temperature, salinity and diet. Coldwater fish contain higher levels of polyunsaturated fatty acids than warmwater fish. Freshwater fish tend to have higher levels of saturated fatty acids than marine fish. The essential fatty acid requirement (EFA) of fish seems to vary from species to species. Coldwater and marine fishes require medium chain ω3 or highly unsaturated long chain ω3 fatty acids. The EFA requirement of warmwater fish is more diverse. Some fish require ω6 and others require a combination of ω3 and ω6 fatty acids.

•Bombeo-Tuburan I. 1989. Comparison of various water replenishment and fertilization schemes in brackishwater milkfish ponds. *J. Appl. Ichthyol.* 5:61-66.

The study was undertaken to determine the optimum combination of the frequency of water replenishment and fertilization that can yield the highest growth, survival, and gross production of milkfish. Results indicated that mean body weight and survival were not

significantly different (P>0.05) among the treatments. Gross fish production was higher in biweekly fertilization if considered as a single factor. However, when this was in combination with the weekly or biweekly water replenishment, similar gross fish production was attained. In any case, because biweekly fertilization has a better effect than a weekly schedule, the former should be used in combination with any other level of replenishment. A weekly water replenishment, however, is impractical in big pond areas of 5-10 ha compartments which are still common in some milkfish ponds in the Philippines. Therefore, biweekly water replenishment and fertilization with 16-20-0 at 50 kg ha^{-1} would be reasonable.

•Bombeo-Tuburan I, Agbayani RF, Subosa PS. 1989. Evaluation of organic and inorganic fertilizers in brackishwater ponds. *Aquaculture* 76:227-235.

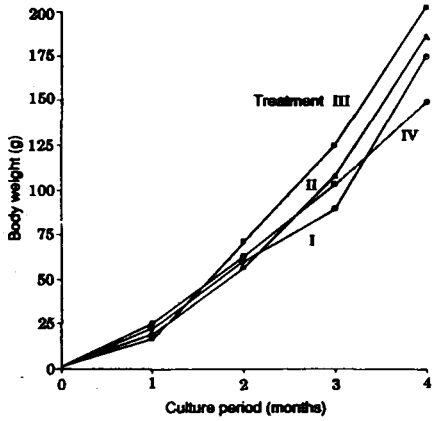
The study was conducted in twelve 144-m^2 ponds to evaluate the effect of different organic and inorganic fertilizers on the growth, survival, gross production, and profitability of marketable milkfish. The following treatments were used: Treatment I, SEAFDEC traditional fertilization practice (16-20-0 at 50 kg/ha and 45-0-0 at 15 kg/ha); Treatment II, half-dosage of Treatment I; Treatment III, chicken manure at 0.5 ton/ha; and Treatment IV, MASA (processed from agricultural and industrial wastes) fertilizer at 0.5 ton/ha. All treatments were applied once in every 2 weeks.

No significant difference (P>0.05) existed in the harvest and production of milkfish among the treatments. However, economic indicators such as return-on-investment (ROI), payback period, and marginal analysis ranked the performance of the fertilizer treatments in the order of I, II, III and IV.

Fish kills occurred in three ponds applied with chicken manure and MASA fertilizer. This could have been due to a heavy build-up of organic matter in the pond bottom which led to the collapse of the benthic algal community, depletion of dissolved oxygen and the presence of hydrogen sulfide. It is therefore suggested that a lower dosage of organic fertilizer should be applied in ponds especially during the rainy season.

•Catacutan MR, de la Cruz M. 1989. Growth and mid-gut cells profile of *Penaeus monodon* juveniles fed water-soluble-vitamins deficient diets. *Aquaculture* 81:137-144.

Growth and changes in the mid-gut cell morphology of *Penaeus monodon* juveniles were evaluated after feeding for 35 days with semi-purified diets deficient in water-soluble vitamins. Diets were prepared by deleting one vitamin at a time from the vitamin supplement consisting of cyanocobalamine, folic acid, thiamine, riboflavin, pyridoxine, niacin, choline, inositol and ascorbic acid. Controls were the complete vitamin diet (control diet 1) and the no vitamin diet (control diet 2). Growth rate was poorest for treatment without vitamin supplement and the inositol and choline-deficient diets. Enhanced growth was observed in prawns fed with the riboflavin-deficient diet. All treatments except control diet 1 showed histopathological changes in the mid-gut cells. Detachment or destruction of the epithelial cells were observed in most cases but more severely in treatments without vitamin supplement followed by inositol, choline and vitamin C.



Growth of milkfish in ponds. I - weekly pond water replenishment, biweekly fertilization (16-20-0 at 50 kg/ha, 45-0-0 at 15 kg/ha); II - weekly replenishment, weekly fertilization (16-20-0 at 25 kg/ha, 45-0-0 at 7.5 kg/ha); III - biweekly replenishment, biweekly fertilization (16-20-0 at 50 kg/ha, 45-0-0 at 15 kg/ha); IV - biweekly replenishment, weekly fertilization (16-20-0 at 25 kg/ha, 45-0-0 at 7.5 kg/ha) (*After* Bombeo-Tuburan, *J. Appl. Ichthyol.* 5:63. 1989).

•Cuvin MLA, Furness RW. 1988. Uptake and elimination of inorganic mercury and selenium by minnows *Phoxinus phoxinus*. *Aquat. Toxicol.* 13:205-216.

Minnows (*Phoxinus phoxinus*) were kept in aquaria containing filtered water dosed with measured amounts of mercury as mercuric chloride and selenium as sodium selenate. Fishes exposed to selenium in combination with mercury showed higher survival rates than those kept in tanks containing mercury alone. A 2 to 1 selenium to mercury molar ratio proved to be the most effective in reducing mercury toxicity. The presence of selenium tended to increase the uptake of mercury from the water. There was no difference in the rate of mercury elimination in the presence or absence of selenium. These results suggest that the observed protective effect of selenium against the toxicity of mercury does not involve reduction of mercury uptake or enhancement of

mercury elimination. The presence of mercury did not affect selenium uptake. Selenium elimination was reduced in the presence of mercury, suggesting that a mercury-selenium complex is formed.

•Cruz ER, De la Cruz MC, Suñaz NA. 1988. Hematological and histological changes in *Oreochromis mossambicus* after exposure to the molluscicides Aquatin and Brestan. Pullin RSV, Bhukaswan T, Tonguthai K, Maclean JL, eds. *The Second International Symposium on Tilapia in Aquaculture; ICLARM Conference Proceedings*; 1987 March 16-20; Bangkok, Thailand. Bangkok, Thailand: Department of Fisheries; Manila: *ICLARM*; 99-110.

Duplicate static 96-hour bioassays were conducted to determine the median lethal concentration for *Oreochromis mossambicus* (LC_{50}) of two organostannous molluscicides, commonly used in fishponds: Aquatin and Brestan. *O. mossambicus* was more sensitive to Brestan. The acute toxicity of both Aquatin and Brestan ceased towards the end of 96 hours. The 24, 48, 72 and 96 hour LC_{50}'s were 4.01, 3.97, 2.95 and 2.58 ppm formulated product for Aquatin and 0.35, 0.18, 0.10 and 0.09 ppm for Brestan, respectively. The computed safe concentrations for Aquatin and Brestan are 0.30 and 0.01 ppm, respectively.

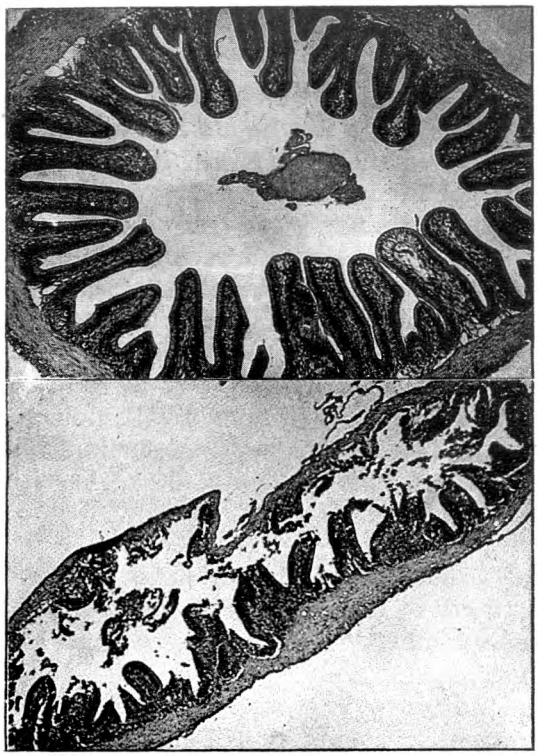
Exposure to lethal concentrations of Aquatin resulted in an immediate reduction in hemoglobin and hematocrit levels. Hemoglobin content was likewise lower in Brestan-exposed fish, whereas, their hematocrit level was higher than that of the control fish.

Histological analyses of gills, intestine, liver and kidney showed pathological changes even in sublethal levels tested. Damage became severe with increasing concentration of the pesticide. The behavior and symptoms exhibited by the fish and the physiology of hematological and histopathological changes are discussed.

•Cruz ER, Tamse CT. 1989. Acute toxicity of potassium permanganate to milkfish fingerlings, *Chanos chanos*. *Bull. Environ. Contam. Toxicol.* 43:785-788.

Potassium permanganate ($KMnO_4$) is a strong oxidizing agent and is commonly used in aquatic systems to improve available oxygen, treat infectious diseases and parasites, detoxify fish poisons, and control algae (Lawrence 1956; Lay 1971; Marking and Bills 1975; Phelps *et al* 1977; Tucker and Boyd 1977; Jee and Plumb 1981). There have been some studies on the toxicity of $KMnO_4$ to freshwater fishes, but none on brackish or marine water species.

The following study was undertaken to determine the 24- and 96-h median lethal concentration (LC_{50}) of milkfish fingerings to $KMnO_4$. The study was also designed to evaluate the histopathological response of fish tissues to $KMnO_4$ but was reported in another paper (Cruz and Tamse 1986).



Oreochromis mossambicus: atrophy (top) and necrosis (bottom) of intestinal mucosa exposed respectively to 4 ppm Aquatin for 96 h and 0.5 ppm Brestan for 1.2 h (*After* Cruz et al., *Second Inter. Symp. Tilapia in Aquaculture,* p. 106. 1989).

•Cruz ER, Pitogo CL. 1989. Tolerance level and histopathological response of milkfish (*Chanos chanos*) fingerlings to formalin. *Aquaculture* 78:135-145.

Static 96-h bioassays were conducted on milkfish fingerings (average weight 6 g) with formalin at concentrations ranging from 50 to 500 ppm. The 24-, 48-, 72-, and 96-h median lethal concentration values (LC50) were 322, 260, 241, and 232 ppm formalin, respectively. Histological analyses of gills, liver, and kidney tissues revealed significant pathological changes even with the sublethal concentrations. The intensity of cell damage increased with increasing concentration and exposure to the chemical. Formalin treatments caused hyperplasia, epithelial separation, and necrosis in the gills; cloudy swelling, hemorrhage, deposition of pigments, and necrosis in liver parenchyma; and degeneration of renal tubules. Partial recovery of tissues was observed in fish after 10 days in formalin-free seawater.

•De la Cruz MC, Erazo G, Bautista MN. 1989. Effects of storage temperature on the quality of

Molds spoil feeds in poor storage conditions. *Aspergillus* (above) produces aflatoxin.

diets for prawn, *Penaeus monodon*, Fabricius. *Aquaculture* 80:87-95.

The effect of storage temperature was evaluated on the basis of growth response of prawns fed for 10 weeks with diets stored at 0°C, 10°C, 28°-31°C (ambient temperatures) and 40°C for a period of 10 weeks. Prawns were stocked at 15 pieces per 60-l oval tank supplied with water at 28°C and 32 ppt in a flow-through aerated system. There were five replicate tanks per treatment. Lowest weight gain (20 g) was observed for prawns fed the diet stored at 40°C and significantly higher growth response was observed as the storage temperature decreased (30.2 g at 28-31 °C; 37.7 g at 0°C and 10°C). Body size was significantly ($P<0.05$) affected by diet after 6 weeks of feeding and highly significantly ($P<0.01$) after 8 weeks of culture. Peroxide values for diets exposed for 10 weeks to 28°-31°C (12.8 meq/kg) and 40°C (15.0 meq/kg) were significantly higher than those exposed to 0° and 10°C (2.9 meq/kg). The highest survival rate (76%) and feed conversion (8.9%) were observed for prawns fed diets stored at low temperatures (0° or 10°C). Severe necrosis of the hepatopancreatic cells was observed in *P. monodon* fed with diet stored at the high temperature.

•De la Cruz MC, Muroga K. 1989. The effects of *Vibrio anguillarum* extracellular products on Japanese eels. *Aquaculture* 80:201-210.

To test the effect of *Vibrio anguillarum* extracellular products (ECP) on Japanese eels, test fish were injected intramuscularly with ECP at a dose of 1 mg protein/100 g body weight of fish. At 3, 6, 12, 24 and 36 h post-injection, blood samples were collected for haematocrit, haemoglobin, and serum protein determinations and tissues were fixed in Bouin's solution. Histopathological observations 24 h post-injection revealed that the ECP caused severe damage to muscle tissue, characterized by extensive muscle liquefaction and haemorrhaging. In addition, extensive haemosiderin deposits were observed in the spleen, with lesser deposits occurring in the kidney and liver. Haematocrit, haemoglobin, serum protein values were lower in ECP-treated fish than in the untreated controls.

•Garcia LMaB. 1989. Development of an ovarian biopsy technique in the sea bass *Lates calcarifer* (Bloch). *Aquaculture* 77:97-102.

A convenient and rapid biopsy method for taking ovarian samples from mature sea bass (*Lates calcarifer* Bloch) is described. Intra-ovarian oocytes siphoned with polyethylene tubing from any region of the ovary provide a sample representative of the maturational stage of sea bass. The osmolality of a 5% phosphate buffered formalin solution is similar to that of sea bass plasma. The follicular diameter of cannulated sea bass oocytes can be measured within an hour after fixation in 5% phosphate buffered formalin without significantly deviating from the diameter of fresh occytes.

•Garcia LMaB. 1989. Dose-dependent spawning response of mature female sea bass, *Lates calcarifer* (Bloch), to pelleted luteinizing hormone-releasing hormone analogue (LHRHa). *Aquaculture* 77:85-96.

The induction of sequential spawnings of mature female sea bass following intraperitoneal implantation of various doses of luteinizing hormone-releasing hormone analogue (LHRHa) in a 95% cholesterol pellet was investigated. LHRHa stimulated a dose-dependent increase in spawning rate (number of spawnings per fish over a 4-day period) at doses ranging from 4.75 to 75 µg/kg body weight. Higher doses ranging from 150 to 300 µg/kg resulted in significantly fewer spawnings (62.5%-75%). Untreated control sea bass did not spawn. Sham-implanted fish failed to spawn or did so at significantly lower rates (0%-6.3%) compared to hormone-treated fish.

Spawning induction at the highest hormone dose tested (300 µg/kg) resulted in the lowest mean egg fertilization rate of 30.1%. Mean fertilization rates, ranging from 60.5% to 82.2%, at the lower doses of LHRHa were not significantly different. Mean hatching rates ranging from 30% to 76.5% following induction of sequential spawning by several doses of LHRHa were similar. At all hormone doses tested, mean egg production levels of 37.3-58.7 x 10^4 eggs/kg body weight were highest on the first day of spawning and declined significantly on subsequent days. Mean egg production levels of 1.2-6.9% x 10^4 eggs/kg were always lowest on the last day of spawning. Similar egg production levels among all hormone doses during each spawning day were observed. These results indicate that the quality and quantity of spawned eggs

may, in part, be influenced by sequential spawnings triggered by LHRHa pellet implantation in sea bass.

Effect of pelleted LHRHa on the spawning, fertilization and hatching rates of mature female sea bass at similar stages of ovarian maturation (initial oocyte diameter = 0.470-0.493mm)* (*Modified* from Garcia, *Aquaculture* 77:89. 1989)

Dose (μg/kg)	Spawning** rate (%)	Fertilization rate (%)	Hatching rate (%)
Untreated	0.0±0.0[a]	-	-
Sham	6.3±6.2[a]	89.6	71.4
37.5	93.7±6.2[b]	81.3±6.7[a]	67.4±10.5[a]
75.0	100.0±0.0[b]	76.3±8.0[a]	68.4±10.5[a]
150.0	75.0±10.2[c]	60.5±7.5[a]	55.9±10.6[a]
300.0	62.5±16.1[c]	30.1±8.9[b]	30.0±13.9[a]

*Values are mean±SEM of four replicate females. For each column, figures with different superscripts are significantly different (P<0.05).

**Calculated as the total number of spawnings for each fish over 4 days multiplied by 100.

•Gonzales-Corre K. 1988. Polyculture of the tiger prawn (*Penaeus monodon*) with Nile tilapia (*Oreochromis niloticus*) in brackishwater fishponds. Pullin RSV, Bhukaswan T, Tonguthai K, Maclean JL, eds. *The Second International Symposium on Tilapia in Aquaculture; ICLARM Conference Proceedings;* 1987 March 16-20; Bangkok, Thailand. Bangkok, Thailand: Department of Fisheries; Manila: *ICLARM*; 15-20.

A study was conducted in fifteen 500-m^2 ponds to determine the growth, survival and production of *Penaeus monodon* (Fabricius) in polyculture with *Oreochromis niloticus* (Linnaeus) and the extent of competition between shrimp and tilapia in brackishwater ponds. The treatments consisted of: (I) *P. monodon* at 6,000/ha; (II) *O. niloticus* at 6,000/ha; (III) *O. niloticus* at 4,000/ha; (IV) *P. monodon* at 6,000/ha plus *O. niloticus* at 6,000/ha; and (V) *P. monodon* at 6,000/ha plus *O. niloticus* at 4,000/ha. A completely randomized design with three replicates was used.

Treatment V gave the highest total production (283.32 kg/ha) followed by Treatment IV (221.24 kg/ha). Treatment I had the lowest total production. Analysis of variance on total production showed significant differences ($p<0.05$) among treatments. Polyculture treatments (Treatments V and IV) were not different in terms of production but significant differences were observed between polyculture (Treatment V) and monoculture treatments (Treatments I, II and III). Mean net production of shrimp alone was highest in Treatment V followed by Treatment I and Treatment IV but were not significantly different between treatments. A similar trend was observed on the mean weight gain and percentage survival of *P. monodon*. Mean net production of *O. niloticus* was relatively low in all treatments. The low production of *O. niloticus* in all treatments was due to low survival (33% to 52%) and slow growth.

Competition was evident between *P. monodon* and *O. niloticus* at a stocking combination of 6,000 *P. monodon*/ha plus 6,000 *O. niloticus*/ha. Total yield from polyculture was better than monoculture. Polyculture of *P. monodon* at 6,000/ha and *O. niloticus* at 4,000/ha appeared feasible.

•Honculada-Primavera J. 1988. Maturation, reproduction, and broodstock technology. *In: Biology and Culture of Penaeus monodon.* BRAIS State-of-the-Art Series No. 2; Aquaculture Department, Southeast Asian Fisheries Development Center; Tigbauan, Iloilo, Philippines; 37-58.

Maturation generally refers to physiological maturity or the development of the gonads or primary reproductive organs producing eggs and sperm capable of fertilization. However, maturation may also refer to functional maturity or the ability to mate with the completion of the secondary sexual organs. In penaeids, the secondary genitalia - thelycum and petasma - develop ahead of the ovaries and the testes.

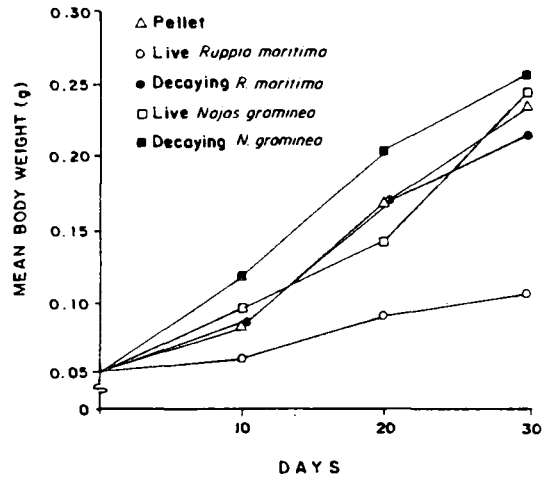
The review describes first maturation in *Penaeus monodon*; endocrine, nutritional, and environmental methods of induced maturation; broodstock constitution; maintenance and other operations; and a comparison of maturation tanks, pens, and cages.

•Honculada-Primavera J, Gacutan R.Q. 1989. Preliminary results of feeding aquatic macrophytes to *Penaeus monodon* juveniles. *Aquaculture* 80: 189-193.

Penaeus monodon juveniles (PL_{50}) were fed live and decaying aquatic macrophytes and a commercial grow-out pellet (40% crude protein) in 80-l glass tanks over a 30-day period. Growth and survival were significantly higher for juveniles fed some form of macrophyte compared to controls (pellets). Survival was highest with live *Najas graminea* (100%) compared to decaying *Ruppia maritima* (65.4%), live *R. maritima* (58.9%) and pellets (52.5%).

Juveniles fed decaying *N. graminea* had the lowest survival rate (30.6%) but the best growth (7.8 mm carapace length (CL), 37.6 mm total length (TL), and 0.2587 g body weight (BW)). The latter body sizes were significantly greater than for juveniles fed pellets (6.2 mm CL, 0.2338 g BW) and other macrophyte treatments. Prawns fed with live *R. maritima* showed the poorest growth (4.5 mm CL, 24.7 mm TL and 0.1070 g BW).

Aquatic plants are directly grazed by penaeid juveniles, or contribute to the detritus fed on by prawns and other benthic organisms. Aside from food, macrophytes also provide cover or shelter from predation and cannibalism.



Mean body weight of *Penaeus monodon* fed two macrophytes and a pelleted feed for 30 days (*After* Primavera & Gacutan, *Aquaculture* 80:191.1989).

•Licop MSR. 1988. Hatchery operation and management. *In: Biology and Culture of Penaeus monodon.* BRAIS State-of-the-Art Series No. 2; Aquaculture Department, Southeast Asian Fisheries Development Center; Tigbauan, Iloilo, Philippines; 59-88.

Considerable advancement has been made in the field of larval rearing of penaeids since the pioneering work of Hudinaga (1942). Hatchery technology has improved from laboratory scale experiments to industry level practice in a span of two decades for the West (Cook and Murphy 1966, Mock et al 1980), and in over just a decade in Taiwan (Liao 1985, 1986, Chiang and Liao 1985), as well as in the Philippines (Villaluz et al 1969, Parado-Estepa and Primavera 1988). Despite the commercial success of hatcheries for *Penaeus monodon* in Taiwan and in the Philippines, the tremendous variability in larval survival makes hatchery production unpredictable.

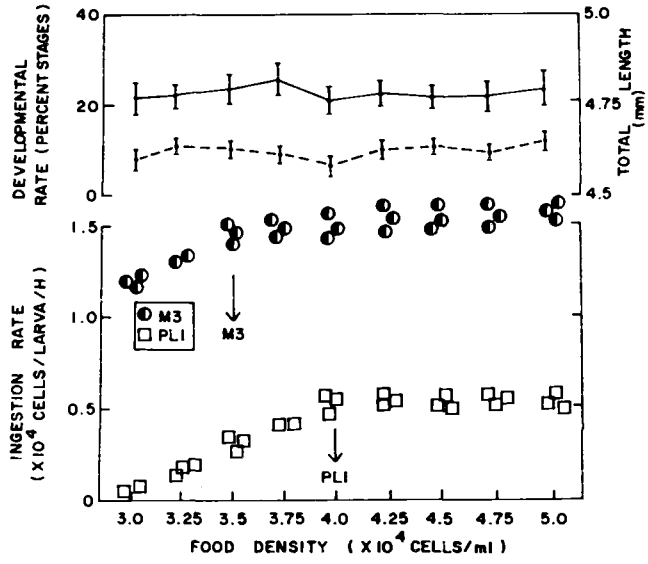
The following state-of-the art for hatchery technology describes the results of basic researches as well as major industry practices relating to the following areas: site selection, hatchery design, larval rearing techniques particularly in the development of live and artificial feed, water management, and nursery practices for postlarvae. Several problems are given attention and recommendation are provided where there are solutions to the constraints presented.

•Lio-Po G. 1988. Prawn health in aquaculture. Chiu YN, Santos LM, Juliano RO, eds. *Technical Considerations for the Management and Operation of Intensive Prawn Farms;* 1987 November 16-20; Iloilo City, Philippines. Iloilo City: UP Aquaculture Society; 130-133.

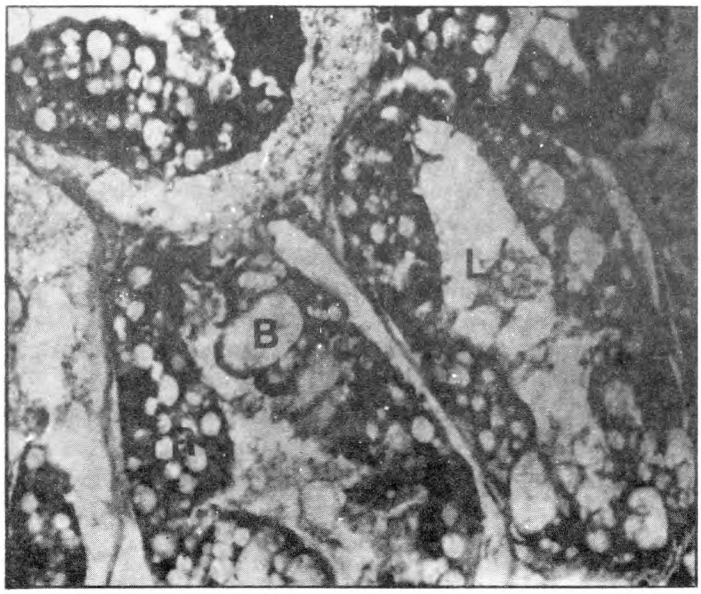
Disease management of intensively-cultured prawns requires an understanding of physiology and disease causation. Maladies result from an interaction of the prawn, disease agents and their environment. In intensive culture, the environment becomes increasingly difficult to control. Hence, surveillance for the early signs of disease, potential pathogens and the development of adverse environmental conditions should be integral components of a sound management system.

•Loya-Javellana GN. 1989. Ingestion saturation and growth responses of *Penaeus monodon* larvae to food density. *Aquaculture* 81:329-336.

Different larval stages of *Penaeus monodon* were fed with increasing densities of *Tetraselmis* sp. to evaluate the relationship between food density, ingestion rates, development and growth of *Penaeus monodon* larvae. Ingestion showed a saturation response to food density. This served as a basis for determining maximum ingestion rates and incipient limiting levels (ILL), defined as the lowest food density to provide maximum ingestion



Ingestion, development, and growth of *P. monodon* larvae fed *Tetraselmis* sp., (mysis 3 to postlarva 1 series). Developmental rate (solid line) and total length (dashed line), determined from larvae that molted to postlarva 1 on termination after 49 h, are presented as means ± s.e.m. Arrows indicate incipient limiting levels for mysis 3 and postlarva 1. Ingestion rate data for PL1 were obtained from postlarva 1 series (*After* Loya-Javellana, *Aquaculture* 81:333. 1989).



Lipid bodies in R-cells (*R*) of midgut of *P. monodon* juvenile fed diet deficient in folic acid, ascorbic acid, or riboflavin. *B*, B-cells; *L*, lumen (*After* Catacutan & de la Cruz, *Aquaculture* 81:142. 1989).

rates (McMahon and Rigler, 1963). Both ILL and maximum ingestion rate increased as larval stage progressed, with maximum ingestion rate reaching a peak at mysis 3 and declining at postlarva 1. When protozoea 1 and protozoea 2 were given *Tetraselmis* sp. at levels equal to or above their respective ILL's, rate of development to protozoea 3 was enhanced. Growth rate, in terms of total length, was significantly enhanced in protozoea 3 and mysis 1 if earlier stages were given *Tetraselmis* sp. at levels equal to or above their respective ILL's.

•Millamena OM. 1989. Effect of FA composition of broodstock diet on tissue FA patterns and egg fertilization and hatching in pond-reared *Penaeus monodon*. *Asian Fisheries Science* 2:127-134.

The effect of dietary fatty acid composition on tissue fatty acid patterns and spawn quality of pond-raised *Penaeus monodon* was evaluated with the use of three practical diets. Diets were formulated to contain the same basal components but with various lipid supplementation: Diet B1, 6% cod liver oil; Diet B2, 3% cod liver oil and 3% soybean lecithin; and Diet B3, 6% soybean lecithin.

Three flow-through maturation tanks were each stocked with 50 broodstock at a sex ratio of 1.5 female to 1 male, with the females ablated on one eyestalk. Broodstock performance measured as total number and nature of spawnings, egg fertility and average hatching rate of eggs of each dietary treatment was assessed.

Results showed that the fatty acid composition of broodstock diet affected tissue fatty acid patterns and hatchability of eggs from pond-reared *P. monodon*. Females fed a diet high in 20:4n-6, 20:5n-3 and 22:6n-3 polyunsaturated fatty acids (PUFA) and n-3/n-6 fatty acid ratio gave higher percentages of fertilized eggs and higher hatching rates than did other diets.

Spawning performance of *Penaeus monodon* broodstock fed diets supplemented with different lipid sources (*Modified* from Millamena, *Asian Fish. Sci.* 2:129, 130. 1989)

Diet	No. of spawnings	Nature of spawnings		Eggs fertilized (%)	Eggs hatched (%)
		Complete (%)	Partial (%)		
B_1	35[a]	79.41	20.59	67.10[a]	36.67[a]
B_2	20[b]	70.00	30.00	63.09[a]	27.27[a]
B_3	29[ab]	72.41	27.59	61.45[a]	19.53[a]

Treatment means with the same superscripts in each column are not significantly different at P>0.05.

Ingredients	%
Squid meal	30.0
Shrimp head meal	20.0
Fish meal	20.0
Wheat flour	5.5
Gulaman (seaweed)	4.0
Rice bran	5.2
Vitamin mix	2.7
Mineral mix	6.0
Cholesterol	0.5
Supplemental lipid	- [a]
Butylated hydroxy toluene	0.1

[a]Diet B_1 - 6% cod liver oil; B_2 - 3% cod liver oil + 3% soybean lecithin; B_3 - 6% soybean lecithin.

•Parado-Estepa FD, Ladja J, de Jesus EG, Ferraris RP. 1989. The effect of salinity on hemolymph calcium concentration during the molt cycle of the prawn *Penaeus monodon*. *Mar. Biol.* 102:189-194.

Prawns (*Penaeus monodon*) were obtained from ponds in Iloilo, Philippines, in 1984 and 1985 and maintained in salinities from 8 to 44 ppt. Total hemolymph calcium was largely affected by molt stage and less so by salinity. A sharp, transient increase in hemolymph calcium occurred 3 to 6 h postmolt, followed by an equally rapid decrease from 6 h postmolt to intermolt. This biphasic response was limited to prawns in 8, 20 and 32 ppt S; in 44 ppt S, hemolymph calcium remained the same throughout the sampling period. Peak concentrations of total calcium were greater in low (8 and 20 ppt S) than in high salinities. Salinity had no effect on the duration of molt cycle nor on time of occurrence of molt.

Almost half of molting incidents occurred between 18.01 and 0.00 hrs, and one-third between 0.01 and 06.00 hrs.

•Parado-Estepa FD. 1988. Selection, transport and acclimation of prawn fry. ***In:*** **Chiu YN, Santos LM, Juliano RO, eds.** ***Technical Considerations for the Management and Operation of Intensive Prawns Farms;*** **1987 November 16-20; Iloilo City, Philippines. Iloilo City: UP Aquaculture Society; 81-85.**

The most important criterion among many used by operators for choosing postlarvae to stock in ponds, is the stage of development. The stages considered suitable for stocking (about PL_{20}) can be identified by examination of anatomical features including the rostral spine number, the length of carapace and sixth abdominal segment. Pigmentation in uropods, size uniformity and activity of postlarvae are useful considerations. During transport, decreasing water temperature to lower metabolic rate helps ensure the adequacy of oxygen in bags. Upon stocking, acclimation to the temperature and salinity of pond water is very important if changes are sudden, regulatory mechanisms may fail, resulting in mortalities.

•Pascual FP. 1989. Effect of various levels of protein, fat, carbohydrates, and energy on growth, survival and body composition of ***Chanos chanos*** **fingerlings. Huisman EA, Zonneveld N, Bouwans AHM, eds.** ***Aquaculture Research in Asia: Management Techniques and Nutrition: Proceedings of the Asian Seminar on Aquaculture*** **organized by IFS; 1988 November 14-18; Malang, Indonesia. Wageningen: Pudoc; 228-236.**

Optimum protein, fat, carbohydrates and energy requirements of milkfish fingerlings were determined using growth, survival and body composition as parameters to assess the effectiveness of the diets. *Chanos chanos* fingerlings weighing 0.5 to 8.0 g were fed semi-purified dry diets consisting of casein and gelatin (4:1), corn oil and cod liver oil (1:1), dextrin, vitamin and mineral mixes, celufil and carboxymethyl cellulose. Treatments consisted of 27 combinations using three levels of protein (15, 30, 45%), fat (0, 6, 12%) and carbohydrates (10, 20, 30%) with two replicates each.

Each replicate consisted of 20 milkfish which were reared for 8 weeks in a flow-through fiberglass tank (40 l volume) using filtered seawater. Temperature and salinity ranged from 26 to 31°C and 30 to 32 ppt, respectively. Feeding rate of dry pellets was 10% of total biomass.

The results indicate that fingerlings require a protein level of 30-40% depending on their size, a fat level of 10% and a carbohydrate level of 25%. Weight gain did not improve if energy levels exceeded 3500 kcal/kg diet.

Based on response surface analysis a summary of possible optimum combinations of protein (%)-, fat (%)-, carbohydrate (%)- and energy levels (kcal/kg) in the diets are: for survival rate, 30/12/10/2540; for weight gain, 30/6/20/2680; for protein deposition 40/6 to 10/20 to 30/2960 to 3740; for fat deposition 40/6/10 to 30/2560 to 3360; for ash deposition 40/6/20 to 30/2460 to 3740.

Of the treatments, the following 5 diet combinations gave mortality rates less than 50%: 15/0/30/1800, 30/12/10/2680, 45/0/10/2220, 45/0/30/2800 and 45/12/20/3780.

Milkfish fingerlings: combinations of protein, fat and carbohydrate levels in diet (*After* Pascual, *Aquaculture Research in Asia: Management Techniques and Nutrition*, p.230.1989)

% Survival	Protein	Fat	CHO	kcal/kg diet	P/E ratio
53	15	0	30	1800	83
55	30	0	30	2400	125
60	30	12	10	2680	112
55	45	0	10	2220	205
58	45	0	30	2680	150
60	45	12	20	3680	122

•Piedad-Pascual FP. 1989. Status of shrimp nutrition and feed development in Southeast Asia. De Silva SS, ed. ***Finfish Nutrition Research in Asia: Proceedings of the Third Asian Fish Nutrition Network Meeting; Asian Fish. Soc. Spec. Publ. 4;*** **1988 June 6-10; Bangkok, Thailand. Manila, Philippines: Asian Fisheries So-ciety; 80-89.**

World demand for shrimp has increased significantly in the last decade. Of the 32 species investigated, the most commonly cultured in Southeast Asia is the *Penaeus monodon*. Formulated feed constitutes around 50% of the operational costs in shrimp culture and hence there is a need to develop low, cost effective feeds. However, due to limited information on feeding habits and nutritional requirements, development of feeds for *P. monodon* has been mainly dependent on data derived from other penaeid species.

Studies on *P. monodon* nutrition and feed development and constraints to shrimp culture common to the Southeast Asian region are reviewed. Standardization of methodologies for nutrition research and husbandry to hasten collection of data is recommended.

•Peñaflorida VD. 1989. An evaluation of indigenous protein sources as potential component in the diet formulation for tiger prawn, ***Penaeus monodon,*** **using essential amino acid index (EAAI).** ***Aquaculture*** **83:319-330.**

Amino acid compositions (g/100 g protein) of different growth stages of *Penaeus monodon* (*Modified* from Peñaflorida, *Aquaculture* 83: 323. 1989)

Amino Acids	Zoea (whole)	Juvenile (whole)	Adult (muscle)
ALA	5.41[b]	5.02[a]	4.95[a]
ARG	5.92[a]	6.57[b]	8.28[c]
ASP	8.42[a]	8.38[a]	8.83[a]
CYS	0.87[b]	0.85[b]	0.63[a]
GLU	11.43[a]	13.20[b]	13.96[c]
GLY	5.10[a]	6.67[b]	4.90[a]
HIS	1.84[b]	2.04[b]	1.91[a]
ILE	3.55[a]	3.66[a]	3.89[a]
LEU	6.23[a]	6.29[a]	6.61[a]
LYS	6.86[b]	6.23[a]	6.80[b]
MET	2.09[a]	2.34[b]	2.30[b]
PHE	3.81[b]	3.45[a]	3.20[a]
PRO	3.46[a]	3.30[a]	3.29[a]
SER	3.60[b]	3.42[b]	3.00[a]
THR	3.32[a]	3.25[a]	3.23[a]
TRY	0.70[a]	0.92[b]	1.07[c]
TYR	3.83[b]	3.24[a]	3.24[a]
VAL	4.31[a]	4.24[a]	4.21[a]
% Crude Protein:	57.89	69.93	93.22

Means in rows with same superscript are not significantly different (P>0.05).

The essential amino acid index (EAAI) could be used in screening potential protein sources. However, when formulating diets, EAAI should be supported with feeding trials and digestibility tests to determine the extent of incorporation of these protein sources in *Penaeus monodon* diets. Using whole *P. monodon* juveniles as the reference protein, local fish meals were found to be good protein sources with an EAAI of 0.92 to 0.95, in addition to white and Peruvian fish meals, shrimp meal, squid meal and soybean meal (EAAI of 0.96, 0.94, 0.98, 0.96 and 0.87, respectively). The amino acid pattern (A/E ratio) of the protozoeal, juvenile and adult stage of *P. monodon* showed increasing arginine and decreasing phenylalanine with growth stage.

•Piedad-Pascual F. 1988. Nutrition. *In: Biology and Culture of Penaeus monodon.* BRAIS State-of-the-Art Series No. 2; Aquaculture Department, Southeast Asian Fisheries Development Center; Tigbauan, Iloilo, Philippines; 119-137.

Through supplemental feeding of prawns, higher stocking densities and a shorter culture period are possible. Increase in production per crop and in the number of croppings per year results in higher return on investment. Thus fish farmers find feeding artificial diets to prawns to be profitable even if operational cost, which is mainly due to feed, increases by 50-60% over that of the traditional method. There is therefore a need to develop an economical and biologically effective diet for prawns.

In the development of artificial diets for prawns, the practical approach is to simulate their food in the natural environment especially when no data on nutrient requirements are available. Dietary requirements of prawns can be obtained from food intake studies in the natural habitat, since available food in ponds is limited and differs from food in the wild. A study of the nutritional needs of the species is necessary. Based upon experience in the poultry and livestock industry, success in these industries came with acquisition of knowledge of nutrient requirements and the development of feeds that met the nutritional needs of the species.

•Quinitio ET, Hara A, Yamauchi K, Mizushima T, Fuji A. 1989. Identification and characterization of vitellin in a hermaphrodite shrimp, *Pandalus kessleri*. *Comp. Biochem. Physiol.* 94:445-452.

1. A female specific protein (FSP, vitellogenin) in hemolymph and its related ovarian protein (vitellin) of *Pandalus kessleri* were studied by means of electrophoretical and immunological procedures.

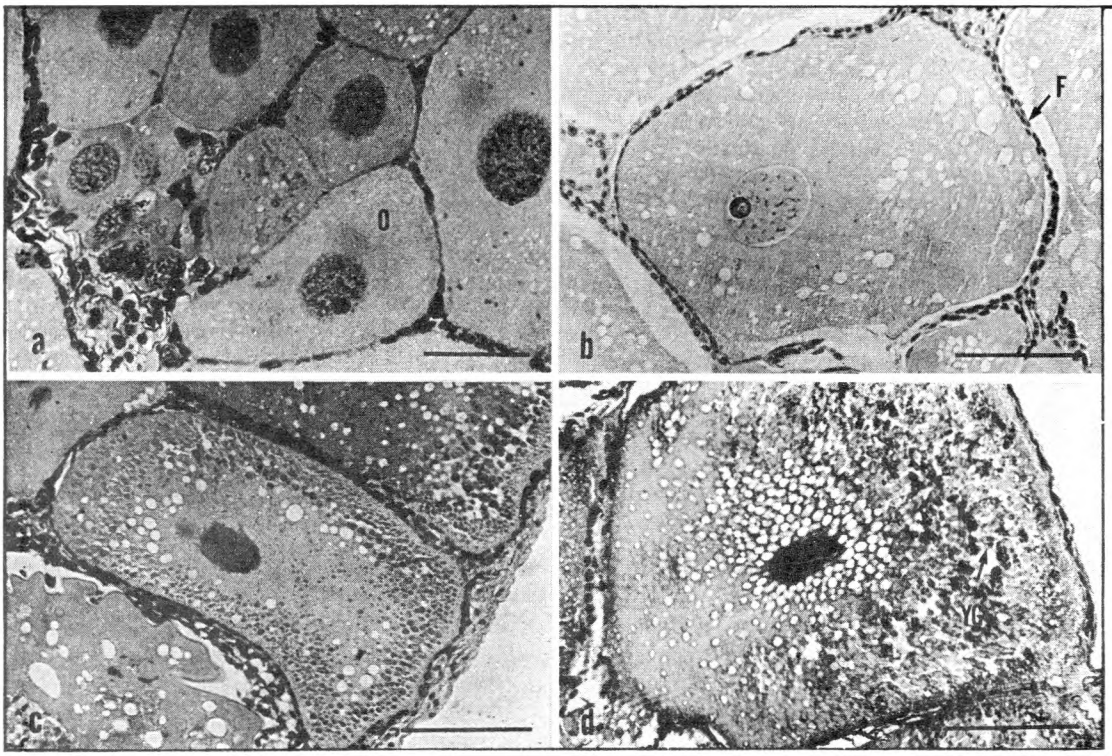
2. The vitellin was purified from vitellogenic ovaries using hydroxylapatite, DEAE cellulose and Sepharose 6B columns, consecutively.

3. The vitellin had a molecular weight of approximately 560 kD and was composed of two subunits, 81 and 110kD, respectively.

4. The vitellogenin concentrations in the hemolymph increased as vitellogenesis in the ovarian oocytes advanced and dropped markedly after the release of mature eggs.

•Quinitio GF, Takahashi H, Goto A. 1988. Annual changes in the testicular activity of the river sculpin, *Cottus hangiongensis* Mori, with emphasis on the occurrence of aberrant spermatids during spermatogenesis. *J. Fish Biol.* 33:871-878.

Annual changes in the spermatogenetic activity of the testis were studied histologically in the river sculpin, *Cottus hangiongensis,* sampled monthly from a river in southern Hokkaido, Japan. A pair of sperm reservoirs, consisting of many anastomosing lacunae, was present along the dorsomedian edge of the paired testes, and functioned also as a sperm-transporting system instead of the typical sperm duct. Spermatogenesis occurred actively in August, yielding an increasing number of mature spermatozoa in October. This process advanced, but slowly during the succeeding winter months, until March. The testis became functionally mature during the spawning period in April and May. In July,



Maturation stages of oocytes of *Pandalus kessleri*: (a) Stage I; (b) Stage II; (c) Stage III; (d) Stage IV. *O*, oocyte; *F*, follicle cells; *YG*, yolk globules. Scales: 100 μm (a), 200 μm (b-d) (*After* Quinitio et al., *Comp. Biochem. Physiol.* 94:446. 1989).

small numbers of spermatocytes were found to have appeared already, which indicated a relatively short period of post-spawning testicular regression. In November, germinal cysts containing aberrant binuclear spermatids began to appear within the seminal lobules. The paired nuclei of aberrant spermatids gradually enlarged, and the cells were released into the lumina of the seminal lobules simultaneously with the release of mature spermatozoa from the germinal cysts. During the functional maturity stage, lumina of seminal lobules which had expelled mature spermatozoa to sperm reservoirs became filled with these abnormal bodies. Discussion includes the occurrence of aberrant spermatids which resulted in the formation of 'spermatid masses' as has been described in other cottids.

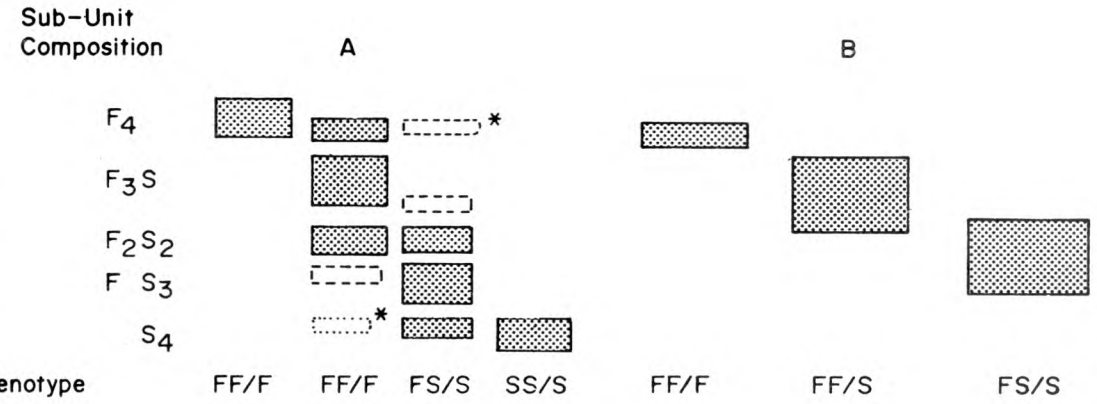
•Romana MRR. 1988. Electrophoretic studies on induced gynogenetic diploid and triploid tilapia (*Oreochromis niloticus* and *O. aureus*). Pullin RSV, Bhukaswan T, Tonguthai K, Maclean JL, eds. *The Second International Symposium on Tilapia in Aquaculture; ICLARM Conference Proceedings;* 1987 March 16-20; Bangkok, Thailand. Bangkok, Thailand: Department of Fisheries; Manila: *ICLARM*; 267-274.

Preliminary electrophoretic screening of laboratory maintained tilapia stocks revealed enzyme polymorphism at three co-dominantly inherited loci-adenosine deaminase (*Ada*), aminopeptidase (*Ap*) and malic enzyme (*Me*-2). *O.niloticus* and *O. aureus* broodstock used in artificial gynogenesis and polyploidy experiments were genetically tagged with these biochemical markers. Results of manipulations to induce diploid gynogenetic and triploid broods from heterozygous females were determined by genetic analysis.

Segregation ratios in the control broods confirmed Mendelian inheritance at the *Me*-2 and *Ada* loci. Genetic analysis of enzyme polymorphism in gynogenetic broods, produced from ova fertilized with genetically inert sperm and heat-shocked 5 minutes after fertilization indicated diploidy restoration by second polar body retention. Diploidization of gynogenomes by suppression of first cleavage of mitosis in the zygote, attempted by heat shocking eggs 20-45 minutes after fertilization with UV-treated sperm, proved effective in one brood (heat shock at 45 min. after fertilization) in which a high incidence (~100%) of individuals homozygous for *Me*-2, was observed. Finally, electrophoretic analysis of triploids revealed banding patterns different from those observed in normal and gynogenetic diploids. Such banding phenotypes, peculiar only to triploids, denoted success in triploidy induction which was achieved here with the fusion of the paternal pronucleus and the maternal genome made double by suppression of meiosis II.

•Santiago AE. 1988. Limnological notes on the finfish production problem of Laguna de Bay. *Nat. Appl. Sci. Bull.* 40:119-121.

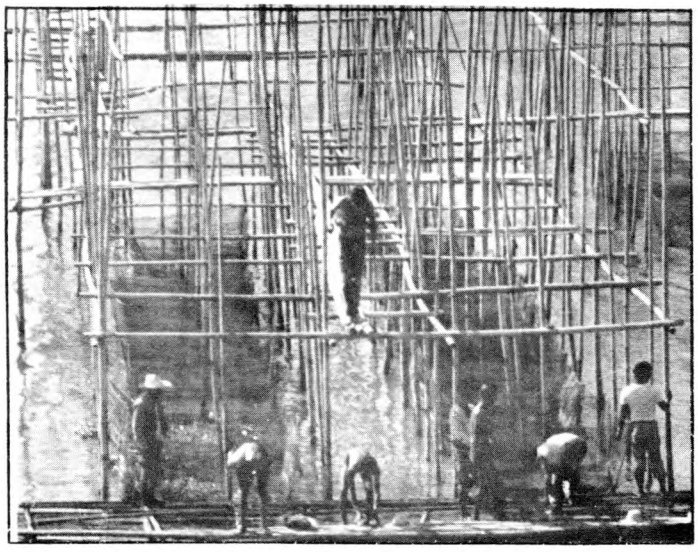
Environmental problems have significantly affected fishery production and management in Laguna de Bay, the largest lake in the Philippines. Fishermen and fishpen operators are complaining



Banding patterns of *Me-2* locus (maleic enzyme) in triploid *Oreochromis niloticus* broods. A, expected pattern; B, observed pattern. *Expected, but not observed, band (*After* Romana et al., *Second Inter. Symp. Tilapia in Aquaculture*, p. 274. 1989).

about the slow growth of fish and low yields in the lake. In the 70's two croppings were possible in fishpens since it took only 3 to 4 months then to rear milkfish from fingerlings to marketable size (Felix, 1976). But in the early 80's, stocked fingerlings attained a marketable size of about 200 g after 8 to 15 months (LLDA, 1983). In 1973 when the total fishpen area was only 5,000 ha, the annual harvest was 4 metric tons (MT)/ha. When fishpens covered 31,000 ha of the lake area in 1982, the annual yield dropped to 2 MT/ha (Centeno et al., 1987). Furthermore, the total open water catch of nearly 83,000 MT in the early 60's (Rabanal et al., 1964) was reduced to one-fourth in the 80's.

While the big drop in yield has been largely attributed to the proliferation and mismanagement of fishpens, over-exploitation of lake resources, and seasonal changes in the productivity of the lake (Centeno et al., 1987), the author attributes the present crisis basically to a lack of understanding of the basic ecological attributes of Laguna de Bay and their relation to fish growth and production. This paper is a brief commentary on the limnological characteristics of Laguna de Bay that are quite important in finfish production.



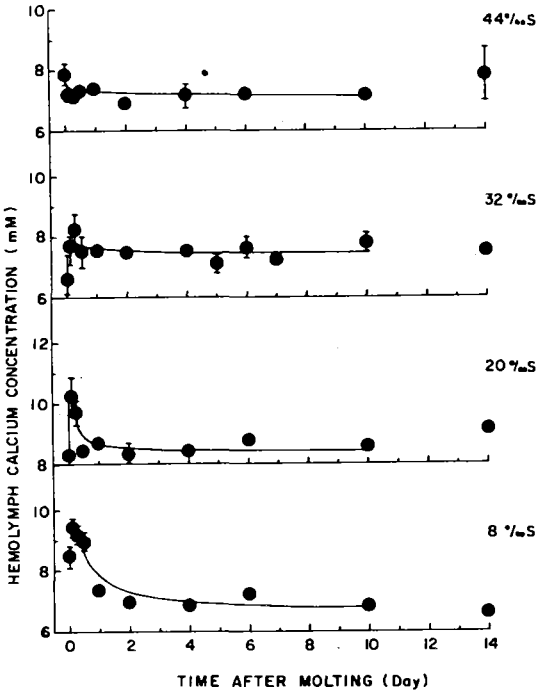
The ecological attributes of Laguna Lake in Luzon Island, Northern Philippines are related to fish growth and reproduction in the lake.

•Santiago CB, Aldaba MB, Reyes OS, Laron MA. 1988. Response of Nile tilapia (*Oreochromis niloticus*) fry to diets containing *Azolla* meal. Pullin RSV, Bhukaswan T, Tonguthai K, Maclean JL, eds. *The Second International Symposium on Tilapia in Aquaculture, ICLARM Conference Proceedings;* 1987 March 16-20; Bangkok, Thailand. Bangkok, Thailand: Department of Fisheries; Manila: *ICLARM;* 377-382.

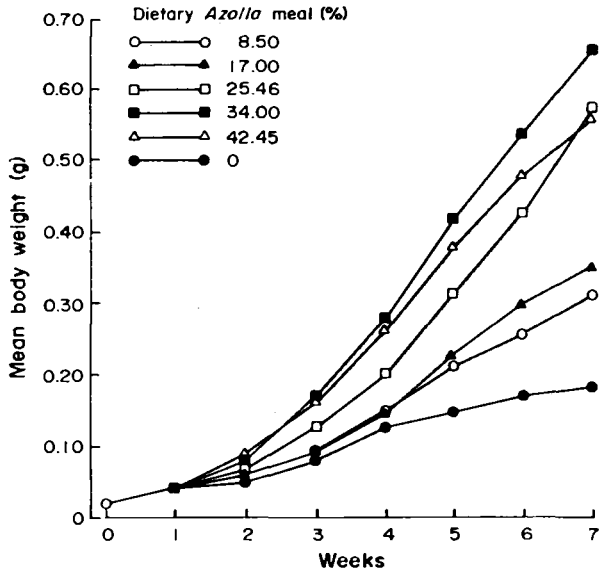
Sun-dried *Azolla pinnata* was ground and incorporated into experimental diets at various levels (8.50, 17.00, 25.46, 34.00 and 42.45% of the diets) to replace fish meal in a control diet isonitrogenously. All feeds contained 35% crude protein and 250 kcal digestible energy/100 g. They were fed to Nile tilapia (*Oreochromis niloticus*) fry (mean body weights, 14.9 mg in Experiment I and 11.2 mg in Experiment II) at 45% of fish biomass daily for 7 weeks. Results of the two experiments showed that *Azolla* meal is a suitable component of diets for Nile tilapia fry. Growth increased and fed conversion ratios improved as the level of the dietary *Azolla* meal increased. Survival rates were not affected by the levels of *Azolla* in the diets.

•Santiago CB, Pantastico JB, Baldia SF, Reyes OS. 1989. Milkfish (*Chanos chanos*) fingerling production in freshwater ponds with the use of natural and artificial feeds. *Aquaculture* 77:307-318.

Milkfish fry were reared to fingerling size in freshwater ponds. For the first experiment, fish were fed the blue-green algae *Oscillatoria* inoculated and grown in the ponds, *Oscillatoria* supplemented with a fishmeal-



Penaeus monodon: effect of water salinity on total calcium concentration in haemolymph as a function of time after molting (*After* Parado-Estepa et al., *Mar. Biol.* 102:191. 1989).



Growth of Nile tilapia (*Oreochromis niloticus*) fry fed diets supplemented with *Azolla* meal (*After* Santiago et al., *Second Inter. Symp. Tilapia in Aquaculture,* p. 380. 1989).

based formulated diet, and the formulated diet alone. Twelve 50-m^2 earthen ponds were prepared to enhance growth of the indigenous natural foods. Acclimated wild milkfish fry were stocked randomly at 90/m^2 and were fed for 6 weeks. Milkfish fed the formulated diet alone had a significantly higher (P<0.05) mean weight gain (1.314±0.201 g) than milkfish given the combination of *Oscillatoria* and formulated diet (0.882±0.230 g). Growth was lowest for fish fed *Oscillatoria* alone. The feeding treatments in the second experiment were: combination of *Spirulina* powder and formulated diet, formulated diet alone, and rice bran alone. The stocking rate was equivalent to 91.5-92.5 fry/m^2 and feeding lasted for 7 weeks. All feeds promoted some growth but the milkfish fed the formulated diet alone invariably had the highest weight increment (1.504±0.167 g), followed by fish given the feed combination (0.881±0.140 g). Rice bran alone gave the lowest growth response. For both pond experiments, growth trends of the young milkfish were similar to those grown under laboratory conditions. Although survival rates were significantly different in one aquarium experiment, survival rates of milkfish in ponds did not differ significantly (P>0.05) among treatments.

•Santiago CB, Reyes OS. 1989. Effect of feeding regimes on growth and survival of bighead carp (*Aristichthys nobilis* Richardson) fry. De Silva SS, ed. *Finfish Nutrition Research in Asia: Proceedings of the Third Asian Fish Nutrition Network Meeting; Asian Fish. Soc. Spec. Publ. 4;* 1988 June 6-10; Bangkok, Thailand. Manila, Philippines: Asian Fisheries Society; 130-136.

Two five-week feeding trials were undertaken to evaluate growth and survival of bighead carp fry of 1.9-2.4 mg mean weight reared on various feeding regimes. In Treatment 1, the carp fry were fed with *Brachionus* alone. In Treatment 2, 3, 4 and 5, the fry were fed with *Brachionus* for 2, 4, 6 and 10 days, respectively, and then with an artificial diet for the remaining period. The carp fry were fed with the combination of *Brachionus* and artificial diet in Treatment 6 and with artificial diet alone in Treatment 7. Results showed that the combination of *Brachionus* and artificial diet was the best feeding regime in enhancing the growth of the bighead carp fry. Mean weights of the fry fed with *Brachionus* for 2, 4, 6 and 10 days prior to the shifting to artificial diet were similar to that of the fry fed with *Brachionus* alone or artificial diet alone. There was no distinct trend in survival as a function of feeding regime. However, *Brachionus* alone gave the highest survival rate in both trials.

•Solis NB. 1988. Biology and ecology. *In Biology and Culture of Penaeus monodon.* BRAIS State-of-the-Art Series No. 2; Aquaculture Department, Southeast Asian Fisheries Development Center; Tigbauan, Iloilo, Philippines; 3-36.

For the culture of any species to evolve from tradition or art to science, basic information on the biology of the species is required.

This paper reviews current information on *Penaeus monodon* including taxonomy, morphology, distribution, and bionomics and life history. The last covers reproduction, development of embryo, larva up to adult, spawning, food and feeding, and physiology.

Problems that have cropped up with the intensification of prawn culture, e.g. discharge of pesticides from grow-out ponds, are highlighted. Other conflicts such as the conversion of mangroves and other estuaries, considered nursery grounds of various marine fauna including *P. monodon*, into fishponds; overexploitation of wild spawners with no stock assessment data; and indiscriminate throwing away of other prawn and finfish fry from wild collections in favor of *P. monodon* fry could adversely affect the ecology of mangroves and other marine ecosystems.

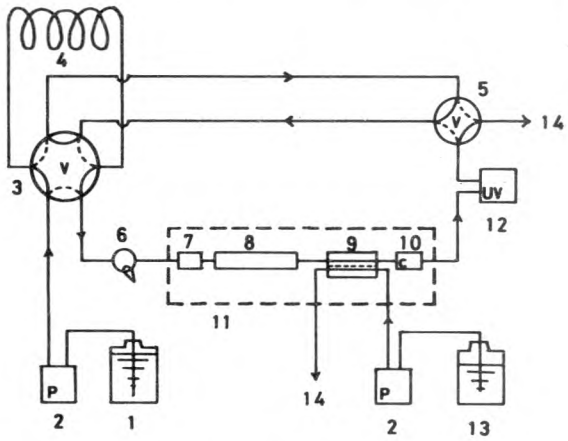
Successes in spawning ensure the supply of shrimp and finfish fry for culture.

Polyculture of *Penaeus monodon* and *Oreochromis niloticus* in brackishwater ponds (*After* Gonzales-Corre, *Second Inter. Symp. Tilapia in Aquaculture*, p. 20. 1989)

Specifications	Mean net production (kg/ha) monoculture	polyculture	Competition index
Competition of *O. niloticus* with *P. monodon*			
6,000 *P. monodon*/ha + 6,000 *O. niloticus*/ha	123.21	80.91	0.34
6,000 *P. monodon*/ha + 4,000 *O. niloticus*/ha	123.21	137.44	-0.12
Competition of *P. monodon* with *O. niloticus*			
6,000 *O.niloticus*/ha + 6,000 *P. monodon*/ha	167.60	140.32	0.16
4,000 *O. niloticus*/ha + 6,000 *P. monodon*/ha	128.52	145.88	-0.14

•Subosa PF, Kihara K, Rokishika S, Hatano H, Murayama T, Kubota T, Hanoka Y. 1989. Ion chromatography of inorganic anions in brine shrimp samples. *J. Chromatogr. Sci.* 27:680-685.

An ion chromatographic method for separating and detecting anions in brine samples is described. Nitrite, bromide, nitrate, and sulfate ions in brine samples are well separated when chloride ion concentration in the sample solution is below 2000 ppm. However, at higher chloride concentrations, nitrite and chloride peaks are not resolved. Low level nitrite ion in the brine sample is separated from a major chloride ion by a heart-cutting and recycling system. After elution, the unresolved portion, including the nitrite ion, is cut and trapped in a 10-ml sample collecting loop and reinjected on the column by using 6- and 4-port valve systems. The detection limit of nitrite spiked in the seawater samples is 0.5 ppm.



Chromatography system for detection of inorganic anions in seawater. 1 = reservoir for eluent, 2 = pump, 3 = 6-port valve, 4 = sample collecting loop, 5 = 4-port valve, 6 = sample injector, 7 = precolumn, 8 = analytical column, 9 = suppressor, 10 = conductivity detector, 11 = oven, 12 = UV detector, 13 = reservoir for scavenger, 14 = drain (*After* Subosa et al., *J. Chromatogr. Sci.* 27:682. 1989).

•Tan-Fermin JD, Pudadera RA. 1989. Ovarian maturation stages of the wild giant tiger prawn *Penaeus monodon* Fabricius. *Aquaculture* 77:229-242.

A qualitative and quantitative study of the ovarian maturation stages of wild-caught *Penaeus monodon* was conducted to refine the existing method of staging. For industrial purposes, measuring the ovarian width at the first abdominal region can minimize arbitrariness in staging. A width of 20 mm indicates readiness for

spawning while reproductive performance is improved when ovarian width is 30 mm or more. Based on histology, the usual 6 to 8 stages of development can be reduced to four stages: previtellogenic, vitellogenic, cortical rod, and spent. The previtellogenic stage (P) is characterized by the predominance of oogonia and primary oocytes in the chromatin nucleolus and/or perinucleolus stage. The vitellogenic stage (V) is marked by the presence of yolky oocytes. The cortical rod stage (C) is distinguished by the appearance of yolky oocytes with spherical or rod-like bodies at the peripheral cytoplasm. The spent stage (S) can be distinguished by the presence of few oocytes with yolky substance and/or cortical rods, thicker layers of follicle cells, and few darkly-stained, irregularly shaped primary oocytes. Individuals classified as stages II+ and III+ showed similarity in size and shape of all lobes in the posterior thoracic region, and histologically, corresponded to the revised stages V and C, respectively. Histochemical staining shows that glycoproteins and lipids are absent in the primary oocytes and present in yolky oocytes. Glycoproteins but not lipids occur in the cortical rods. Analysis of variance showed significant differences in mean gonad weight and gonadosomatic index values but not in the mean body length and body weight values in stages P to C. Uniformity in the number, stage and composition of oocytes in the four regions of the ovary at each stage showed that stage of ovarian maturity in wild prawns can be represented by any region of the ovary. Differences in the oocyte size frequency and mean values of average and maximum oocyte diameter in the four stages showed that these are good indicators of stage of maturation in wild *P. monodon*.

•Triño AT, Fortes RD. 1989. Food preference of wild milkfish juveniles in connection with habitat and food available. *J. Aquacult. Trop.* 4:1-7.

Through quantitative determination of the gut content of wild milkfish (*Chanos chanos*) juveniles, the study aimed to evaluate the food preference of the fish in relation to its availability in the pond so that necessary measures can be taken to provide such food to the feeding organisms. Wild juveniles of milkfish and plankton samples were collected in a mangrove lagoon at Nabunut Island. Various types of food organisms found in the mangrove plankton samples and food components in the gut of milkfish were then tabulated and compared. The gut content of the fish examined showed a preponderance of detritus, plant debris and fine sand particles. These organic materials without mixture of live food organisms were found in 64.5% of the fish collected. Other food ingested consisted of live food organisms but their proportion in the gut was smaller compared to the proportion found in the natural environment. Milkfish juveniles, upon entering depositional environments, prefer to feed on detritus. The pathway of energy flow in this kind of environment is for the food to pass through a detrital chain before being utilized by milkfish. The functional concept and evidence of this pathway is not restricted to natural ecosystems but may also prevail in pond environments.

Percentage of plankton organisms in the gut of milkfish juveniles (A) and in the environment (B), and percentage of milkfish juveniles with these organisms in their gut (C) (*Modified* from Trino & Fortes, *J. Aqua. Trop.* 4:4. 1989)

Organism	(A)	(B)	(C)
Phytoplankton			
Filamentous green algae	65.57	11.47	34.21
Diatoms			
Navicula	3.52	25.24	9.65
Nitzschia	5.40	28.62	3.07
Amphora	0.06	1.90	2.19
Bacteriastrum	0.23	0.04	1.30
Closterium	0.71	1.80	0.88
Surirella	0.06	0.18	0.88
Leptocylindrus	-	0.8	-
Coscinodiscus	-	0.5	-
Synedra	-	0.35	-
Pleurosigma	-	0.30	-
Melosira	-	0.10	-
Rhizosolenia	-	0.08	-
Asterionella	-	0.06	-
Trichodesmium	-	0.04	-
Skeletonema	-	0.03	-
Thallasiothrix	-	0.03	-
Biddulphia	-	0.01	-
Zooplankton			
Copepods	6.45	21.34	32.02
Dinoflagellates	17.87	2.22	3.95
Brachionus	0.07	0.93	0.88
Crustacean larvae	0.07	0.93	0.88
Nematodes	-	2.65	-
Fish eggs	-	0.36	-
Others			
Detritus	-	-	100.00
Plant debris	-	-	100.00
Sand grain	-	-	100.00

Total number of milkfish juveniles collected and analyzed = 228; with no live food organisms in their gut = 147.

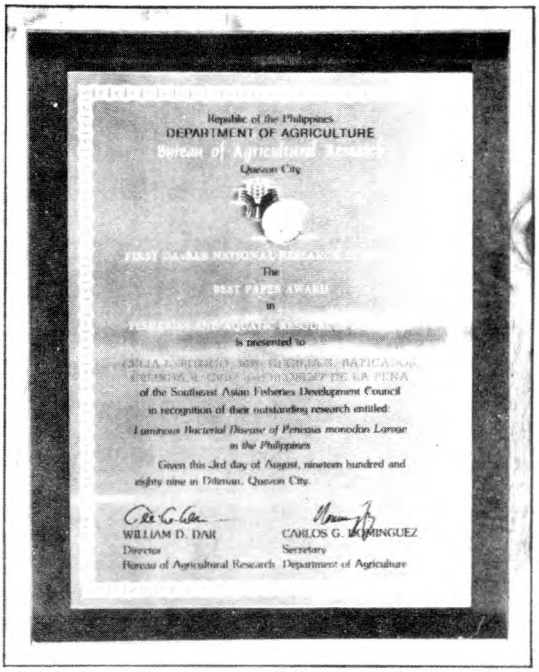
Research Seminars

Date	Title	Speaker
19 Jan	Dietary studies in the yellowtail (*S. quinqueradiata*), Japanese flounder (*P. olivaceus*), and black tiger prawn (*Penaeus monodon*)	K. Kuroki*
20 Jan	Publishing in *Aquaculture*	GAE Gall*
31 Jan	Sea bass culture in Australia	J. Russel, C. Keener, N. Gillespic*
2 Feb	Effects of dietary fiber on protein utilization of supplemental feeds of milkfish in brackishwater ponds	N. Sumagaysay
17 Feb	The effect of carbohydrate levels on growth and apparent protein digestibility in *Penaeus monodon*	M.R. Catacutan
23 Feb	Sex determination in tilapia	G.C. Mair*
2 Mar	Effect of lipid intake on growth of milkfish fry	V.R. Alava
9 Mar	Disease diagnosis and control in Indonesian shrimp hatcheries	M.C.L. Baticados
10 Mar	Coral reefs management and fish sanctuaries	A.C. Alcala*
10 Mar	Mangrove reforestation and eel grass communities	M. Fortes*
14 Mar	Country-side development through small-scale fisheries: seafarming and territorial use rights	F.J. Lacanilao
17 Mar	Improved larval production of Asian sea bass (*Lates calcarifer*) using HUFA-enriched live food	P. Dhert
22 Mar	Induced spawning of bighead carp (*Aristichthys nobilis*) by intraperitoneal injections of LHRHa and domperidone	A.C. Fermin
6 Apr	Dietary manipulation to control the chronic softshell syndrome in tiger prawn, *Penaeus monodon*	M.N. Bautista
6 Apr	Defatted soybean meal and *Leucaena* leaf meal as protein sources for *Penaeus monodon* juveniles	F.P. Pascual
10 Apr	Economic analysis of an integrated milkfish broodstock and hatchery operations as a public enterprise	R.F. Agbayani
11 Apr	Growth performance and survival of *Oreochromis niloticus*, *O. mossambicus* and their F_1 hybrids at various salinities	C.T. Villegas
26 Apr	Development and improvement of a new system for crustacean maturation study using live food	J. Queiroz*
27 Apr	Utilization of *Artemia* biomass as a feed source in aquaculture	P.A. Tackaert
4 May	Farming of mud crab (*Scylla serrata*) at different stocking densities in ponds	E. Rodriguez
11 May	Effect of different salinity levels on spawning/hatching, and	Y. Yashiro

	larval rearing of white shrimps (*Penaeus indicus* and *P. merguiensis*)	
18 May	Studies on the functional morphology of the testis in two species of freshwater sculpins	G.F. Quinitio
25 May	The ecological, social and economic implications of intensive prawn farming	J.H. Primavera
15 June	Identification, purification and characterization of vitellin in shrimp, *Pandalus kessleri*	E.T. Quinitio
6 July	Use of reference fish as internal control for environmental variance in tilapia strain comparison	Z.U. Basiao
13 July	In-house publishing at AQD: PRC, Publications Section, etc.	I.J. Dogma,Jr.
3 Aug	Identification and control of bacteria isolated from exoskeletal lesions of the tiger prawn, *Penaeus monodon*	G. Lio-Po
16 Aug	Intensive kuruma prawn (*Penaeus japonicus)* culture in Japan	E. Coniza
24 Aug	Endogenous and exogenous ammonia excretion in sea bass	J.M.E. Almendras
7 Sept	Effect of dietary lipid sources on the reproductive performance of *Penaeus monodon* broodstock	O. M. Millamena
14 Sept	Effects of dietary stress on the growth of three Nile tilapia strains	M.R. Romana
28 Sept	Hormonal induction of spawning mature female sea bass, *Lates calcarifer* (Bloch)	L. Ma. B. Garcia
2 Oct	The biology and phenology of the *Sargassum* beds in Bolinao, Pangasinan	G. Trono, Jr.
9 Oct	Female-specific protein, lipovitellin, molting cycle and ovary index of *Penaeus monodon*	R. Yashiro
12 Oct	Preliminary results on the field cultivation of *Gracilaria* utilizing vegetative fragments	A. Ponce
19 Oct	Induction of sex inversion in juvenile grouper, *Epinephelus malabaricus*, by biweekly injections of 17 α-methyltestosterone	J.Tan-Fermin
30 Oct	Deep water rice-fish culture	P. Mukhopadhyay*
16 Nov	Body size profile and reproductive capability of six *Brachionus plicatilis* stocks given different algal feeds in semi-continuous culture	M. de la Peña
23 Nov	Size and weight-dependent cannibalism in hatchery-bred sea bass, *Lates calcarifer*	M. Parazo
7 Dec	Salinity adaptations in the milkfish, *Chanos chanos*	C. Swanson*

*Visiting Scientist

Research Awards


Republic of the Philippines
DEPARTMENT OF AGRICULTURE
Quezon City

The
BEST PAPER AWARD
in

is presented to

of the Southeast Asian Fisheries Development Council
in recognition of their outstanding research entitled:
Luminous Bacterial Disease of Penaeus monodon Larvae in the Philippines
Given this 3rd day of August, nineteen hundred and eighty nine in Diliman, Quezon City.

WILLIAM D. DAR
Director
Bureau of Agricultural Research

CARLOS G. DOMINGUEZ
Secretary
Department of Agriculture

AQD won the best paper award in the Fisheries and Aquatic Resources Category in the first national research symposium of the Bureau of Agricultural Research, Department of Agriculture (Philippines).

The paper was "Luminous Bacterial Disease of *Penaeus monodon* Larvae in the Philippines" by C.L. Pitogo, M.C.L.Baticados, E.R.Cruz, and L. de la Peña, and earned a cash award of US $150 and a plaque. The paper was presented in the symposium held 2 August 1989 in Diliman, Quezon City, Philippines.

The abstract of the winning paper follows:

"Larvae mortalities associated with luminescence occurred in epizootic proportions in black tiger prawn (*Penaeus monodon*) hatcheries in Panay Island, Philippines. Luminescent vibrios, identified as *Vibrio harveyi* and *V. splendidus,* were isolated from infected larvae but not from uninfected ones. These bacteria were also recovered readily from seawater samples from nearshore areas, the main source of hatchery rearing water. Thus, it is possible that the nearshore seawater is the source of infection.

"Pathogenecity tests with *V. harveyi* resulted in significant mortalities of larvae and postlarvae of *P. monodon* within 48 h of challenge. Scanning electron microscopy showed bacterial colonization of the feeding apparatus and oral cavity of the larvae, suggesting an oral route of entry for the initiation of infection."

Last year, two AQD papers tied for first place in the prestigious *Elvira O. Tan Memorial Award for Fisheries Research* given by the Dept. of Science and Technology, Philippines: *The effect of diet on the reproductive performance of pond-reared Penaeus monodon Fabricius broodstock* authored by AQD Research Associate Oseni M. Millamena with Jurgenne H. Primavera, Rosario A. Pudadera, and Rosemarie V.Caballero, and the other, *Effects of supplementary lecithin and lipid sources on the growth and survival of Penaeus monodon juveniles* by Felicitas Piedad-Pascual, AQD Scientist. AQD also won the best scientific paper for the first *Dr.Elvira O. Tan Memorial Award* in 1987. Entitled *Studies on the chronic soft-shell syndrome in the tiger prawn Penaeus monodon Fabricius in brackishwater ponds,* the paper was written by AQD Research Associate Ma. Cecilia Baticados with co-author Relicardo Coloso and Roselyn Duremdez-Fernandez. It was published in *Aquaculture.* In the same year, three AQD junior scientists won the *Naga Award* (given to the best scientific paper in fisheries and aquaculture written by authors from a developing country) of the International Center for Living Aquatic Resources Management (ICLARM) for their paper *The effects of water hardness on the hatching and viability of silver carp (Hypophthalmichthys molitrix) eggs* published in *Aquaculture.*

TRAINING

Mandated to develop human resources for aquaculture, AQD continued to receive trainees from Member Countries as well as other nationals for regular short-term training programs on various aspects of aquaculture.

During the year, AQD conducted the following training courses:

Training Courses

Seventh UNDP/FAO-NACA-UPV-SEAFDEC/AQD Senior Aquaculturists Training Course

Eighteen participants completed the one-year (17 March 1988-16 March 1989) UNDP/FAO-NACA-UPV-SEAFDEC/AQD Training Course for Senior Aquaculturists in Asia and the Pacific Region. The participants were from the People's Republic of China (2), India (1), Indonesia (1), Republic of Korea (1), Malaysia (1), Philippines (8), Sri Lanka (2), Thailand (1), and the Socialist Republic of Vietnam (1).

The training course was conducted at TRS and LBS of SEAFDEC/AQD, the University of the Philippines in the Visayas (UPV), and the Network of Aquaculture Centres in Asia (NACA) regional lead centers in India, Thailand, and China. The degree Masters in Aquaculture was awarded to the graduates by UPV during its 1989 commencement exercises.

Fish Health Management

The Fish Health Management Course was conducted from 16 February to 15 March at TRS. Two participants came from Indonesia, four from Malaysia, seven from the Philippines, and four from Thailand. Ten participants were sponsored by SEAFDEC, six by the Government of the Netherlands through the Direct Aid to Educational Establishments in Developing Countries Programme, and one by the UN Food and Agriculture Organization.

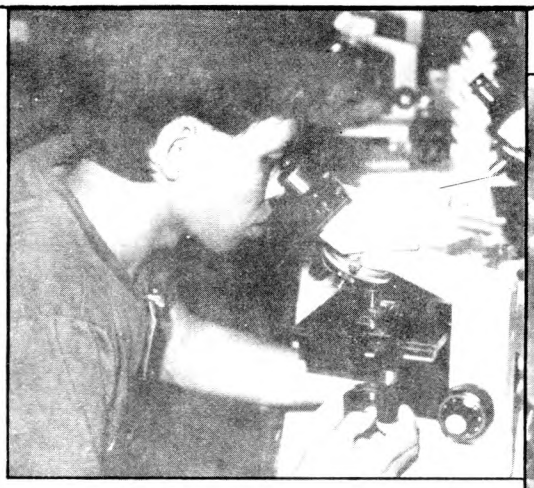
Culture of Natural Food Organisms

The training was held from 11 April to 9 May at TRS and attended by 12 trainees from six countries, i.e., Philippines (4), Thailand (3), Malaysia (2), Indonesia (1), Sri Lanka (1) and the Yap State (1). Seven of the trainees enjoyed SEAFDEC fellowships, four were funded by the Food and Agriculture Organization, and one was supported by the International Development Research Centre of Canada.

Brackishwater Pond Culture

The one-month training course conducted 11 May-9 June at TRS and LBS was participated in by 14

SEAFDEC/AQD Training Courses: annual occasions for a gathering of Asian and other nationals eager to learn the fundamentals and practice of aquaculture. Above, the Department Deputy Chief, trainors, and first (1989) batch of trainees (14) in Fish Nutrition.



Fish Health Management (top), Prawn Hatchery & Nursery Management and Operations (right) and Hatchery of Marine Finfishes (page bottom) are favorite training courses, respectively with 17, 41 and 18 trainees in 1989, most of them under the sponsorship of their governments, FAO/UNDP, ADB, USAID, IDRC, and SEAFDEC.

trainees from the Philippines most of whom came from the private sector.

Prawn Hatchery and Nursery Management and Operations

A total of 23 Filipino participants attended the first session of the seven-week training held from 16 May to 4 June at TRS. Most of the participants came from the private sector.

The second session conducted from 1 August to 19 September was attended by 18 participants from the Philippines (6), Malaysia (3), Singapore (1), Thailand (1), Indonesia (3), Papua New Guinea (1), Sri Lanka (2), and Nigeria (1). Fellowships were provided by SEAFDEC (4), FAO (1), ADB (2), and the US Agency for International Development (2).

Hatchery of Marine Finfishes

The course was conducted at TRS. Eighteen trainees from four countries: the Philippines (13), Thailand (2), Malaysia (2), and Nigeria (1) attended the course from 11 July to 29 August. Five participants were supported by SEAFDEC while the others were funded by the Philippine Government, the Government of Nigeria, and the private sector.

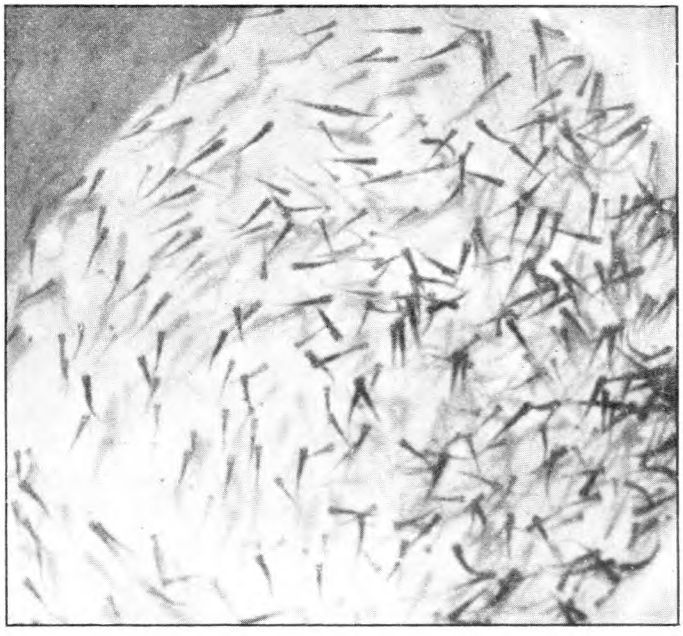
Fish Nutrition

The course was conducted at TRS from 13 September to 24 October with 14 trainees from five countries, i.e., the Philippines (7), Thailand (3), Malaysia (2), Sri Lanka (1), and Papua New Guinea (1). Nine of the participants were sponsored by SEAFDEC, one by the Asian Development Bank, one by the Food and Agriculture Organization, one by the Universiti Sains Malaysia, and two by the Philippine Human Resources Development Center.

Training Programs

Practicum Training

Thirty-seven graduating students from fisheries schools underwent practicum training at the following TRS laboratories: Phycology, Finfish Hatchery, Microtechnique, *Artemia*, and Nutrition; and one was



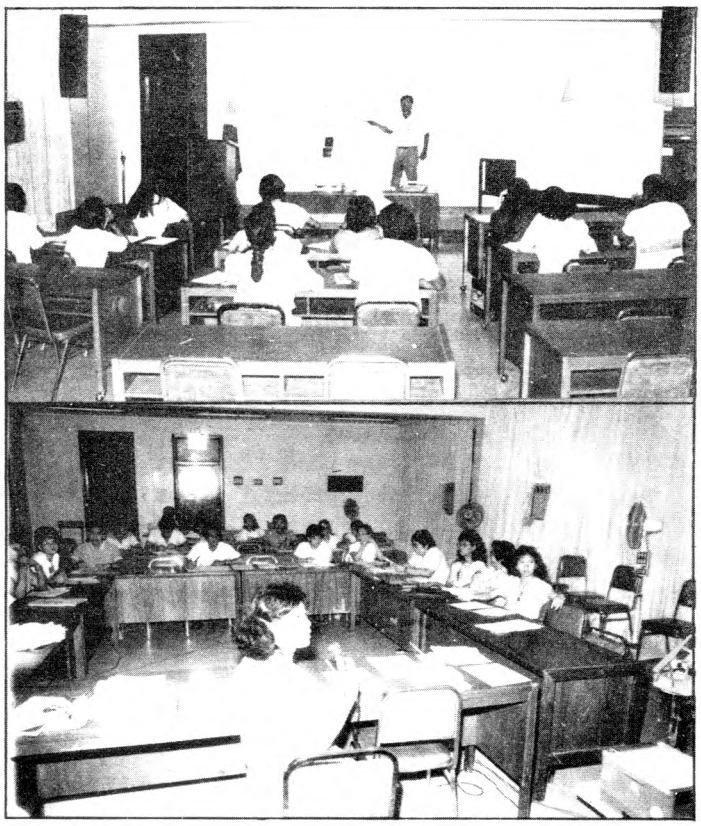
trained in pond culture at LBS. At the Binangonan Freshwater Station (BFS), eight students trained in different areas of aquaculture research.

Internship Training

Forty Filipinos and three Indonesians were accepted for internship training in the following fields: Phycology, Microtechnique, Fish Health, Chemistry, and Finfish Hatchery. For the Indonesians, the internship formed an extension of their attendance in earlier regular training courses.

Summer Youth Training Program

Pursuant to President Aquino's directive to formulate a program that will encourage students and out-of-school youth to engage in more productive endeavors during summer, AQD implemented a summer youth training program from 1 to 30 June 1989. A total of 25 trainees were accommodated, nine of them under the internship training at BFS, while 16 were on-the-job trainees at LBS and Igang Substation.



SEAFDEC/AQD researchers and invited specialists train the trainees (top) and themselves undergo training in the fundamentals of training (bottom).

Course	*Countries*
7th Senior Aquaculturists Training Course	
17 March 1988 - 16 March 1989	-18 Trainees
People's Republic of China	
India	Philippines
Indonesia	Sri Lanka
Republic of Korea	Thailand
Malaysia	Vietnam
Fish Health Management Training Course	
16 February-15 March 1989	- 17 Trainnes
Indonesia	
Malaysia	
Philippines	
Thailand	
Culture of Natural Food Organisms	
11 April-9 May 1989	- 12 Trainees
Indonesia	
Malaysia	Thailand
Philippines	Yap State
Sri Lanka	
Prawn Hatchery & Nursery Management and Operations	
16 May-4 June, 1 August- 19 September	- 41 Trainees
Indonesia	Philippines
Malaysia	Singapore
Nigeria	Sri Lanka
Papua New Guinea	Thailand
Brackishwater Pond Culture	
11 May-9 June 1989	- 14 Trainees
Philippines	
Hatchery of Marine Fishes	
11 July-29 August	- 18 Trainees
Malaysia	
Nigeria	
Philippines	
Thailand	
Fish Nutrition	
13 September- 24 October	- 14 Trainees
Malaysia	
Papua New Guinea	
Philippines	
Sri Lanka	
Thailand	

EXTENSION

Extension services to the host country were generally carried out in coordination with the Philippines' Department of Agriculture (DA) through a series of outreach seminars and farm visits. All these activities were geared to benefit the local small fish farmers and the poor fisher folks.

Extension activities also included participations in fairs and exhibits, assessment of the adoption of the small-scale shrimp hatchery technology, and the holding of the "Save-the-Fish" Poster-Slogan Contest.

Outreach Seminars, Farm Visits

AQD research personnel served as resource persons in the following seminars:

• Series of seminars on shrimp and milkfish culture conducted by the Regional Agricultural and Fishery Council in Region XI, specifically in Tandag, Surigao del Sur; Mati, Davao Oriental; General Santos City, South Cotabato; and Digos, Davao del Sur, 20 January to 5 February.

• Training seminar on shrimp culture conducted by the Bicol Regional Fishermen's Training Center in Tabaco, Albay, 16-17 March, attended by Agricultural Production Technologists, DA personnel, and fishpond operators.

• Live-in seminar on shrimp culture, and nutrition and feed development for the fish farmers of Malandog, Hamtik, Antique, Philippines, 30-31 March. Thirty-four small fish farmers and local DA staff attended the seminar, which AQD co-sponsored with the DA-Regional Rural Development Project-Antique Integrated Small-scale Fisheries Development Project.

• First Prawn Encounter in Bicol Region convened by DA, the Provincial Agricultural and Fishery Council of Camarines Sur, and the Naga City Chamber of Commerce and Industry (NCCI), 21-22 May, in Naga City, Camarines Sur, Philippines, attended by shrimp growers from Region V, NCCI Investors, DA personnel, and fish farmers.

• A Fishery Technician-Clientele Seminar on Scientific Approach to Prawn Farming conducted by the United Davao City Prawn Growers Association, Inc. and DA. Fifty participants comprising DA Agricultural Production Technologists, shrimp farmers, technicians, and feed dealers attended the seminar.

• Training seminar on shrimp culture, tilapia and carp pen and cage culture, and polyculture of finfishes in Legaspi City, Albay, Philippines 26 to 28 July, conducted by AQD in cooperation with the DA, attended by small fish farmers, DA Personnel, and Agricultural Production Technologists.

• Consultation-visits by researchers to the Prawn Hatchery Project in Bais City, 4-6 September, through the Extension Program, Silliman University; to *Gracilaria*-fish ponds of Trappist Monks, Igdarapdap, Nueva Valencia, Guimaras, 22 September, through the DA Secretary; to Pan-ay, Capiz, 31 August-1 September, to assess the utilization of bean clams, through the mayor of Pan-ay; to farms in Guimaras Island and Concepcion, Iloilo, 28-30 June.

Fairs and Exhibits

AQD joined the **Tigbauan Agro-Industrial Fair,** Tigbauan, Iloilo, 13-15 January which has for its theme "More Livelihood Projects for Socioeconomic Development." The fair coincided with the annual fiesta celebration of the municipality.

On 7-11 April, AQD participated in the **Agri-Aqua Fair** in Iloilo City in commemoration of the 88th founding anniversary of the Province of Iloilo.

AQD joined the **6th Agri-Aqua Livestock and Poultry Fair '89** jointly sponsored by the Department of Agriculture and the Philippine Center for International Trade and Exhibition (PHILCITE), 26 May to 4 June, at the Cultural Center of the Philippines Complex, Metro Manila. AQD also participated in the **Technolohiya Pampamilya '89** sponsored by SALVAPUL BAMUR, an economic district in Negros Occidental composed of the municipalities of Salvador Benedicto, Valladolid, Pulupandan, Bago and Murcia, 1-4 June.

Also participated were the **Agri-Food Fair '89** in Bacolod City, Negros Occ., 6-10 December, sponsored by DA and PHILCITE; and **Agribition '89** in Iloilo City, 11-18 December, sponsored by the RAFC and DA.

Participations in the fairs included conduct of aquaculture seminars, demonstrations and consultations, video showing of research activities, and photo and publications exhibits.

Techno-Transfer Assessment

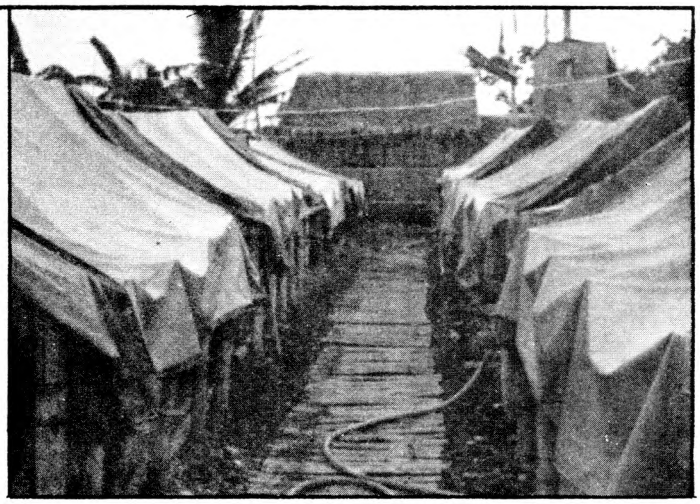
The Department conducted a survey to assess the extent of dissemination, transfer, and adoption of the small-scale prawn hatchery technology developed at SEAFDEC/AQD, to the underlying areas of AQD's Tigbauan Research Station. The survey covered five municipalities and one district in Iloilo City.

Actual count for the southwestern coastal areas in the Province of Iloilo registered a total of 91 operational hatcheries and 12 under construction as of 31 March 1989, compared to only 44 in December 1988.

The preliminary findings are as follows:

Number of runs/year	: 6-8 runs
Production	: 100,000-500,000 fry/run
Fry stage at harvest	: PL_{16}-PL_{20}
Hatchery floor area	: 300-500 m^2
Cost of fry	: Min -₱0.14/pc; Max -₱0.25/pc
Cost of spawner	: ₱300-500/piece (Stage III) ₱800-900/piece (Stage IV)
Investment	: ₱100,000-200,000 capital outlay ₱10,000-15,000/run
Hatchery facilities	: 1-4 units of concrete tanks or marine plywood tanks (12-ton capacity) 1-4 units concrete algal tank (1-5 ton capacity)

The most common problems cited by the operators and technicians included the following: (1) occurrence of diseases in the hatchery, (2) high mortality of fry, (3) inadequate supply of spawners, (4) very erratic price of fry, (5) lack of technical consultants and skilled technicians, and (6) lack of regular fry buyers.

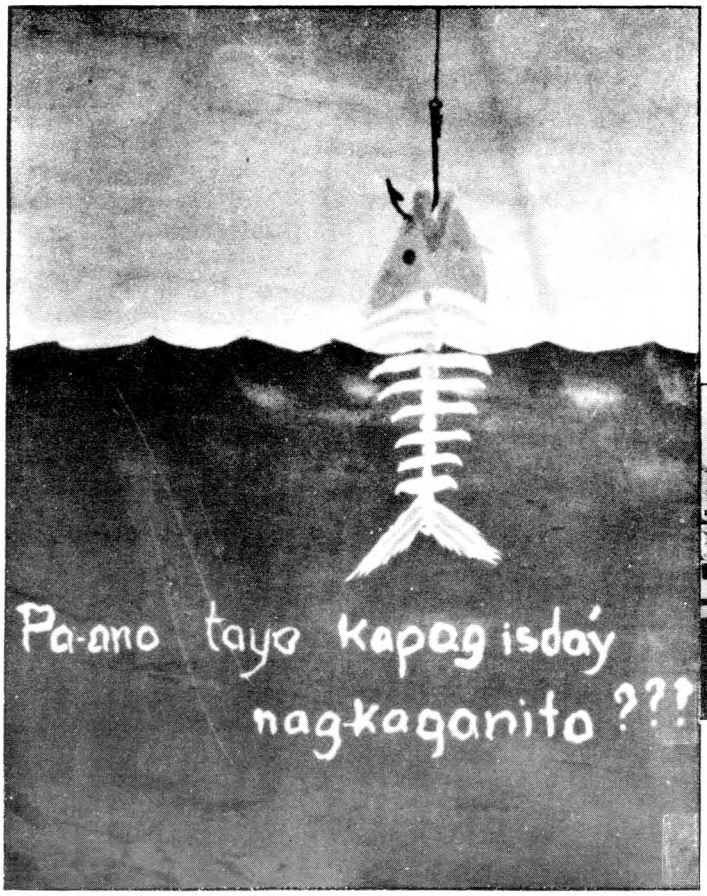


Small-scale shrimp hatcheries proliferate in the vicinities of Tigbauan Main Station - 44 in Dec. 1988, 91 + 12 under construction in Mar. 1989.

"Save-the-Fish" Poster-Slogan Contest

To foster awareness among the Philippine citizenry of the importance of fishery resource conservation, AQD, with financial assistance by SEAFDEC Secretariat, held the "Save-the-Fish" Poster-Slogan Contest in Region VI (Western Visayas), Philippines.

A total of 529 entries were received from children aged 10 and below. The first prize (US $500 plus trophy) went to a Grade III pupil from Iloilo City, two second prizes (US $350 plus trophy) went to a Grade III pupil also from Iloilo City and to a Grade IV pupil from Bacolod City, while the third prize (US $250 plus trophy) went to a Grade III pupil from Alimodian, Iloilo. Ten consolation prizes (US $50 each) were also awarded.



Toward conservation of fishery resource: AQD 1989 "Save-the-Fish" Poster-Slogan Contest. Top, winners with top officials of the Department; left, first prize entry (original in full color, 8 1/2x11").

INFORMATION

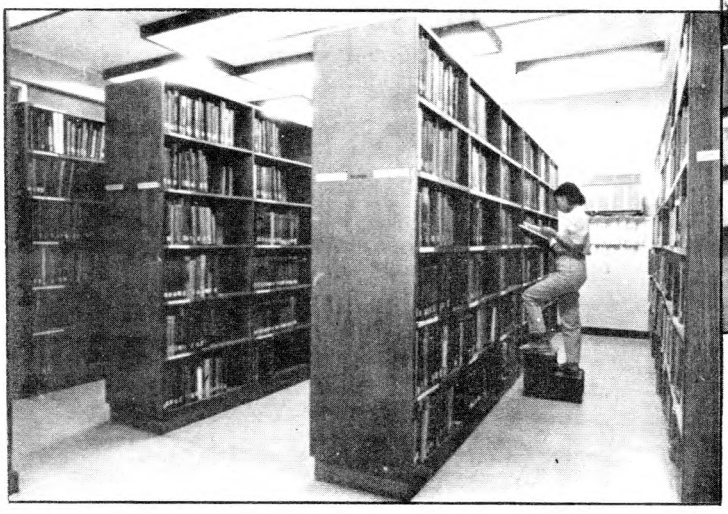
AQD continued acquisition and processing of information materials through its library and documentation services. Production of in-house publications was intensified. Manuals, pamphlets, newsletters, and other extension materials were produced and circulated worldwide.

Library Services

Accessioned were 538 monographic volumes, 195 pamphlets and 154 SEAFDEC publications. Checklisted were 1,706 journal issues (912 from Gifts and Exchanges, and 794 from paid subscriptions). Also received from Gifts and Exchanges were 456 monographs, 446 reprints, 20 pamphlets, 6 new journal titles, 10 microfiches, and 74 brochures, posters, leaflets, and annual reports.

The present collection stands at 9,224 monographic volumes; 4,725 pamphlets; 1,997 SEAFDEC publications; and 3,403 journal volumes.

A total of 7,949 readers were recorded for 997 hours of library service during the second half of 1989, making an average of 8 readers per hour. A total of 745 external users were also recorded during the period, with students, researchers, and faculty members of the University of the Philippines in the Visayas.



Documentation Services

A total of 72 queries from 24 countries were served, about 60% of which were queries on specific titles. Requests came mostly from researchers and students, and their queries were on prawn, shrimp, grouper, molluscs, and aquaculture in general.

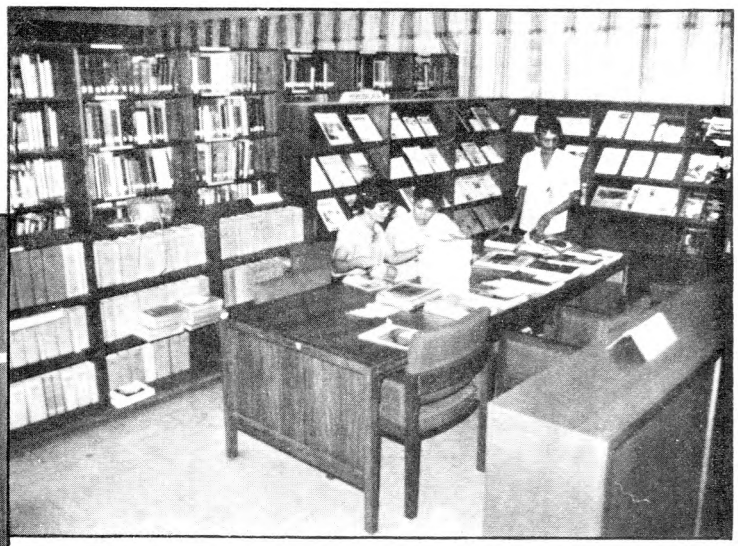
There are now 438 records added to the SEAFIS data base of Filipiniana fisheries and aquaculture, bringing to a total of 1,768 records in the SEAFIS data base.

BRAIS Networking

The BRAIS data base now contain about 5,000 entries. These were acquired through survey, acquisition, exchange program arrangements, and networking activities. Through PhilBRAIS, a Literature Collection Travel was conducted in Luzon Area, the Philippines in February-March, and a total of 161 materials were gathered. Received from IndoBRAIS were 1 conference proceedings, 1 monograph, 1 journal issue, 6 technical papers, 42 input sheets, and 1 thesis; from MalayBRAIS -4 theses and dissertations, and 18 monographs; and from ThaiBRAIS, 237 input sheets.

SEAFIS Activities

Participation of AQD in the SEAFIS project of the SEAFDEC Secretariat came in the form of compilation of materials for the Philippine component in the Regional Fisheries Bibliography, and compilation of the Philippine Fisheries Bibliography:



SEAFDEC/AQD library, one of the richest in aquaculture literature in Asia: 9,224 monograph volumes, 4,725 pamphlets, 3,403 journal volumes, 1,997 SEAFDEC publications. In 1989 745 non-AQD personnel used the facilities and 72 written inquiries from 24 countries were served.

- *Regional Fisheries Bibliography*
  Philippine literature on fisheries and aquaculture with publication dates beginning 1985 were collected from the AQD Library collection, inputted into the SEAFIS worksheets and sent to SEAFDEC Secretariat, Bangkok, Thailand. A total of 441 records (bibliographic information) were dispatched to SEAFIS.

- *Philippine Fisheries Bibliography*
  Compilation of materials for Philippine Fisheries Bibliography began with the assessment of the AQD Library collection of Philippine literature on fisheries and aquaculture. Initial assessment revealed that at least 1,768 records could be included in the compilation. In addition, AQD's Filipiniana records showed a total of 438 bibliographic information for inclusion in the compilation.

Publications

Printed in 1989 were the following:

Aquaculture Extension Manuals (AEM)

Nutrition and Feeding of P. monodon, AEM No. 3, Third Edition.

Farming of Prawns and Shrimps, AEM No. 5, Fourth Edition.

Broodstock of Sugpo, Penaeus monodon Fabricius, AEM No. 7, Fourth Edition.

Prawn Hatchery Design and Operation, AEM No. 9, Fourth Printing, Second Edition.

Biology and Culture of Sea Bass (Lates calcarifer), NACA Training Manual Series No. 3, reprinted with permission as AEM No. 11.

A Prototype Warm Water Shrimp Hatchery, NACA Training Manual Series No. 4, reprinted with permission as AEM No. 12.

An Improved Traditional Shrimp Culture Technique for Increasing Pond Yield, NACA Tech. Series No. 5, reprinted with permission as AEM No. 13.

Shrimp Hatchery Design, Operation and Management, NACA Training Manual Series No. 1, reprinted with permission as AEM No. 14.

Shrimp Culture: Pond Design, Operation and Management, NACA Training Manual Series No. 2, reprinted with permission as AEM No. 15.

Aquaculture Extension Pamphlets (AEP)

Recent Developments in Prawn Pond Culture and Management, AEP No. 1.

Feeding Prawns for Grow-Out Culture, AEP No. 2.

Recommended Practices for Diseases Prevention in Prawn and Shrimp Hatcheries, AEP No. 3.

Culture of Sea Bass, SAFIS No. 11, reprinted in May.

Newsletters

SEAFDEC Asian Aquaculture (quarterly)
Vol. X, No. 3, September 1988
Vol. X, No.4, December 1988
Vol. XI, No. 1, March 1989
Vol. XI, No. 2, June 1989
Vol. XI, No. 3, September 1989
Vol. XI, No. 4, December 1989

Aqua Farm News (bimonthly)
Vol. VI, No. 6, November-December 1988
Vol. VII, No. 1, January-February 1989
Vol. VII, No. 2, March-April 1989
Vol. VII, Nos. 3 & 4, May-June, July-August 1989
Vol. VII, No. 5, September-October 1989
Vol. VII, No. 6, November-December 1989

Internal Newssheet
Aqua Dep't News (fortnightly)
Twenty-five issues were published.

Poster

Poster No. 2, *Life cycle of prawn, Penaeus monodon*

BRAIS Publications

Brackishwater Aquaculture Abstracts
Vol. 4, No. 3, November-December 1987
Vol. 4, No. 4, January-February 1988
Vol. 4, No. 5, May-June 1988
Vol. 4, No. 6, August-September 1988

Milkfish Abstracts

Directories
Directory of Brackishwater Aquaculture Scientists
Directory of Brackishwater Aquaculture Institutions

State-of-the-Art Review
Biology and Culture of Penaeus monodon

BRAIS Newsletter (quarterly)
Vol. 3, No. 4, October-December 1988
Vol. 4, No. 1, January-March 1989

Department publications are made available worldwide to various clientele. Left, Sales/Circulation room for AQD-produced publications.

ADMINISTRATION

Resource optimization continued to be a management concern. Administrative policies took into account efficient and effective utilization of manpower and infrastructures.

Personnel

As of 31 December 1989, the regular staff of AQD totaled 383, with 167 in Research, 17 in Training, 27 in Information, 126 in Administrative, 25 in Finance, and 21 in the Office of the Chief.

AQD also availed of the services of the following foreign scientists and local consultants: Satoru Fukumoto, Deputy Chief; Tsuneo Kume, Akimasa Nagai, Japanese Experts; Gavino Trono, Consultant for Seaweeds Project; R. Gotera, Editorial Consultant; Eduardo Rondain, Personnel and Legal Consultant; Hector Teodosio, Consultant/Legal Counsel; and Philippe Dhert, Research Associate.

Voluntary Resignation Package

On 26 January 1989, AQD implemented a voluntary resignation package for its employees who resigned during the period 1 January to 28 February. The package included an increased resignation benefit equivalent to one month gross pay multiplied by the number of years in the service, plus P2500 for every year of service. This was intended to achieve an acceptable ratio of research to non-research personnel, at the same time providing acceptable resignation benefits. One hundred fifty-nine resigned from AQD, 144 of whom availed themselves of the voluntary resignation package.

Administrative Committee

Pursuant to Regulation 20 of the Administrative Regulations, the Administrative Committee for AQD was created, composed of the Deputy Chief; the Heads of Administration, Research, Training, Information, and Finance Divisions; and the Head of Internal Audit. The Committee is chaired by the Head of Administrative Division.

Hospital Insurance Plan

Pursuant to Regulation 15 of the Administrative Regulations, a Group Hospital Insurance Plan was adopted for all AQD regular employees and their eligible dependents effective 1 March 1989.

New Allowance

In anticipation of the New Minimum Wage Law, an additional monthly allowance of ₱900 was granted to employees of AQD regardless of rank effective 1 June 1989. Part of this allowance was subsequently integrated in the employees salaries, as provided for by law.

Incentive Allowance for Senior Research Staff

An incentive allowance system for senior research staff was adopted effective 1 June 1989. The system provides cash incentives to AQD senior research staff who have published research papers in scientific journals covered in *Current Contents*. This system was intended to stop further loss of senior researchers.

Amended Pay Scale

The pay scale of the Department was amended to accommodate wage increases mandated by the Government of the Philippines. Reasonable increases were also made in the salaries of senior research staff.

Royalty/Honorarium for Authors of AQD In-House Publications

The guidelines on the granting of royalty and honorarium to authors of AQD in-house publications and other communication materials were revised giving more benefits to the authors.

Upgrading of Employees

Upgrading of employees under the existing position classification was made effective upon satisfaction of the minimum requirements of the job.

Staff Development and Activities

Human resource development was pursued with the attendance of several of the staff in degree and non-degree programs; participations in symposia, conferences, and seminar-workshops; and involvement in technical consultations.

The AQD personnel who benefited from the staff development program are as follows:

- Degree Program
  - **G. Quinitio** - Doctor of Fisheries Science, Hokkaido University, Hokkaido, Japan, through Monbusho scholarship grant.
  - **R. Buensuceso** and **J. Saliente** - Master of Aquaculture, University of the Philippines in

the Visayas, Philippines, through NACA scholarship grant.

D. Estenor - M.S. in Marine Ecology, Vrije Universiteit Brussels, Belgium, through fellowship grant from the *Artemia* Reference Center.

R. Fernandez is pursuing further graduate studies on Fish Diseases (Fish Virology) at Hokkaido University, Japan starting April, through Monbusho scholarship grant.

A. Gallego is pursuing a Ph.D. program at the Universidad de Henares, Madrid, Spain beginning July, through scholarship grant from Universidad de Henares.

Z. Basiao is pursuing doctoral degree in Biology (Fish Genetics) at Dalhousie University, Halifax, Nova Scotia, Canada beginning September, under IDRC fellowship grant.

C. Marte is completing a doctoral degree in Zoology at the University of Singapore under IDRC fellowship grant.

G. Lio-Po is pursuing doctoral degree in Biological Sciences at the Simon Fraser University, Burnaby, British Columbia, Canada beginning August, under IDRC fellowship grant.

- Non-Degree Program
  - **A. Gallego** - 12-month training in shellfish depuration and bivalve culture at IFREMER Laboratory, France
  - **E. Coniza** - 11-week training on intensive prawn culture in Kagoshima, Japan
  - **E. Cruz** - 8-month training program on Tropical Fish Health at the Universiti Pertanian Malaysia
  - **A. Gonzal** - 4-month 9th Training Course in Integrated Fish Farming in Wuxi, People's Republic of China
  - **C. Pitogo** - 10-day training course on Disease Diagnosis and Control in Marine Shrimp Culture in Tuczon, Arizona, U.S.A. and a 3-month training course in Bacteriology at Simon Fraser University, British Columbia, Canada
  - **G. Lio-Po** - 2-month training on Fish Virology at Pacific Biological Station, British Columbia, Canada
  - **A. Duller** and **D. Reyes, Jr.** - 3-month International Training Course on *Artemia* at Ghent, Belgium
  - **M. de la Peña** and **N. Guanzon, Jr.**, - 1-month Advance Mesocosm training course in Xiamen, China

- Attendance in international seminars, symposia and conferences, and involvement in technical consultations:
  - **J. Primavera** - Third Meeting of the Provisional Governing Council of the Network of Aquaculture Centres in Asia (NACA), Bangkok, Thailand, 10-13 January
  - **M.C. Baticados** - Technical Fish Health Program at the Universiti Pertanian Malaysia (UPM), 23-27 January, and IDRC Workshop on Histopathology also at UPM, 30 January-4 February
  - **V. Sulit, M.C. Ortega** and **D.Z. Bermejo** - SEAFIS Seminar on Fishery and Aquaculture Information in Southeast Asia, Bangkok, Thailand, 7-10 February
  - **D. Bermejo** - Echo-seminar on CDS/ISIS operations for ThaiBRAIS Project staff in Bangkok, Thailand, 11-15 February
  - **C. Marte** and **F.P. Pascual** - Workshop on Advances in Tropical Aquaculture, Tahiti, 20 February-4 March
  - **W. Gabuelo** - Echo-seminar on CDS/ISIS for MalayBRAIS and MALFIS staff in Penang, Malaysia, 12-18 March
  - **E. Aralar** - First Workshop on Ulcerative Fish Disease and Environment, Bangkok, Thailand, 20-24 March
  - **L. Cababasay** - Echo-seminar on CDS/ISIS for IndoBRAIS staff in Jepara, Indonesia, 26 March-1 April
  - **F. Lacanilao, F. Pascual, G. Po, C. Villegas, Z. Basiao, R. Romana, M. Bautista, L.M. Garcia, R.Agbayani** - Second Asian Fisheries Forum in Tokyo, Japan, 17-22 April
  - **C. Marte** - XIth Symposium on Comparative Endocrinology, Malaga, Spain, 14-20 May, and satellite symposium on Applications of Comparative Endocrinology to Fish Culture, Almunecar, Granada, 22-23 May
  - **O. Millamena** and **J. Fermin** - 5th International Conference on Invertebrate Reproduction, Nagoya, Japan, 23-28 July
  - **M.C. Baticados** - Malaysian Fisheries Society Forum in Aquaculture, Kuala Lumpur, Malaysia, 14-19 August and lectured on Prawn Diseases, Singapore, 19 August
  - **J. Primavera** - Third National Coordinators Meeting of the Regional Seafarming Development and Demonstration Project in Quindao, China, 24-27 August, and visit to the Asian Pacific Regional Research and Training Centre for Integrated Fishfarming in Wuxi, China, 30 August-1 September
  - **M. Parazo** and **V. Alava** - International Fish

Nutrition Symposium, Keelung, Taiwan, 6-7 September

R. Agbayani - Workshop in Sanitation and Marketing of Molluscs, France, 15-28 October

J. Primavera - 3rd Brazilian Shrimp Training Congress, Joao Pessoa, Brazil, 16-20 October.

A. Santiago, M.R. Romana and **R. Eguia** - Aquaculture Genetics Network Conference, Singapore, 12-18 November

J. Fermin - International Symposium on Hormones and the Environment, University of Hong Kong, Hong Kong, 18-20 December

- Attendance in national seminars, symposia and conferences, and involvement in technical consultations:

A. Triño and **G.P.B. Samonte** - Seminars on prawn and bangus culture in Tandag, Surigao del Sur; Mati, Davao Oriental; General Santos City; and Digos, Davao del Sur, 20 January - 5 February

I. Dogma, Jr. - Seminar on prawn culture, pest and diseases in the Regional Demonstration Center of DA-III, Hanga, Hagonoy, Bulacan, 21-23 February

R. Roldan - Module I: Basic Course on Training Needs Analysis and Facilitating Techniques, Philippine Human Resources Development Center (PHRDC), Manila, 6-10 March

F. Lacanilao, J. Primavera and **J. Lagoc** - Regional Symposium on Coastal Fisheries Conservation and Development, Iloilo City, 9-11 March

K. Corre - Seminar on Prawn Culture, Bicol Regional Fishermen's Training Center, Tabaco, Albay, 16-17 March

A. Santiago and **A. Gonzal** - Seminar on Setting up of Environmental Standards for Developing Countries, Manila, 30-31 March

V. Sulit - Workshop on Agriculture Statistics, Iloilo City, 31 March

N. Golez - Iloilo Inventors Forum, Iloilo City, 9 April

P. Dhert and **R. Bombeo** - Seminar on Commercial Hatchery Techniques of Fish, Prawns and Other Crustaceans, Manila, 15 April

V. Sulit - Seminar on Communicating Government Programs, Development Academy of the Philippines (DAP), Tagaytay City, 17-21 April

R. Buensuceso - AQUASOC Aquaculture Kapihan on Investment Prospects of Intensive Milkfish Culture, Iloilo City, 13 May

L. Oniate - Training-Workshop on Basic Audio-Visual Production Techniques, Manila, 15-26 May.

R. Espinosa, Jr. - Seminar on Practical Strategies in Materials Management, Bacolod City, 23-25 May

V. Peñaflorida - 5th Chemistry Congress, Los Baños, Laguna, 25-27 May

V. Alava and **I. Borlongan** - 14th Annual Convention of the Philippine Biochemistry Society, 23-30 May, and Seminar-Workshop on Basic Concepts in Biochemistry, 2 June, Manila

V. Sulit - Iloilo Provincial Agricultural and Fishery Council (PAFC) Workshop, Iloilo City, 8 June

C. Marte, O. Millamena, M.C.L. Baticados, F. Pascual, C. Villegas, I. Dogma, Jr., A. Ponce, J. Primavera, G. Po and **A. Santiago** - Regional Workshop on the National Aquatic Resources Research and Development Systems Five Year R and D Plan, University of the Philippines in the Visayas (UPV), Miag-ao, Iloilo, 15-17 June

J. Primavera - Module II: Training Design and Methodology, PHRDC, Manila, 19-23 June

J. Lagoc, R. Buendia and **A. Surtida** - Training-Workshop on Basic Print Materials Production Techniques, PHRDC, Manila, 19-30 June

L. Cababasay - Mini-Micro CDS/ISIS Assembly, Manila, 21-23 June

A. Triño and **R. Buensuceso** - First Iloilo Small Fishpond Operators Association Meeting, Iloilo City, 30 June

P. Triño - Training course in Office Automation, Iloilo City, 10-14 July

R. Alger - SGV Foundation Lectures, Metro Manila, 24-28 July

F. Pascual, E. Rodriguez, N. Solis, A. Triño, I. Tuburan and **K. Corre** - Shrimp Farmer Workshop, Metro Manila, 28-29 July

J. Saliente - Training on Evaluation and Monitoring (Module III), PHRDC, Metro Manila, 21-24 August

D. Baticados - Seminar on Relating Performance Appraisal with Compensation, Metro Manila, 21-25 August

C. Cendaña and **M. Junio** - Technical Writing Program, DAP, Tagaytay City, 4-8 September

M. R. Luhan - Seminar on Light Measurement and Other Topics Related to Plant Growth and Aquatic Resources, Los Baños, Laguna, 12-13 October

M. Ortega - Seminar-Workshop on Cataloguing and Classification and Strategies for Computerization of Library Processes, Batac, Ilocos Norte, 19-21 October

S. San Juan and **R. Mamauag** - Technical Writing Program at the Development Academy of the Philippines, Tagaytay City, 23-27 October

A. Arago and **R. Eguia** - Tilapia Genetics Workshop, Central Luzon State University, Muñoz, Nueva Ecija, 30 October-6 November

W. Gallardo - ASEAN Symposium on Bivalves at PHRDC-SRDC, Dagupan City, Pangasinan, 6-8 November

R. Alger and six **Finance staff** - Symposium on The Central Bank, the Banking Institutions and the Public: Tripartism Towards National Development, Iloilo City, 9 November

Staff of Finance Division and Internal Audit - Operations Seminar and Update Sessions (7 sessions) conducted by SGV Auditors, SEAFDEC/AQD, Tigbauan, Iloilo, starting 10 November

G. Garcia - Information Systems Planning Seminar, 14 November-9 December, and the Training Course on Management and Implementation of Foreign-Assisted Projects, 27 November-8 December, Makati, Metro Manila

H. Juntaria - Training in Audio-visual Equipment Repair and Maintenance, PHRDC, Metro Manila, 19 November-8 December

N. Ebron, E. Natividad and **A. Duremdez** - Conference/Seminar on Business Management, Metro Manila, 20-24 November

J. Almendras - French language course at Alliance Francaise, Cebu City, 1 December to January 1990, in connection with 4-year scholarship grant in France

M.G. Gariando -Seminar on Infratic Analyzer, Metro Manila, 4 December

A. Ponce - 5th Seaweed Industry Conference, Cebu City, 7-8 December

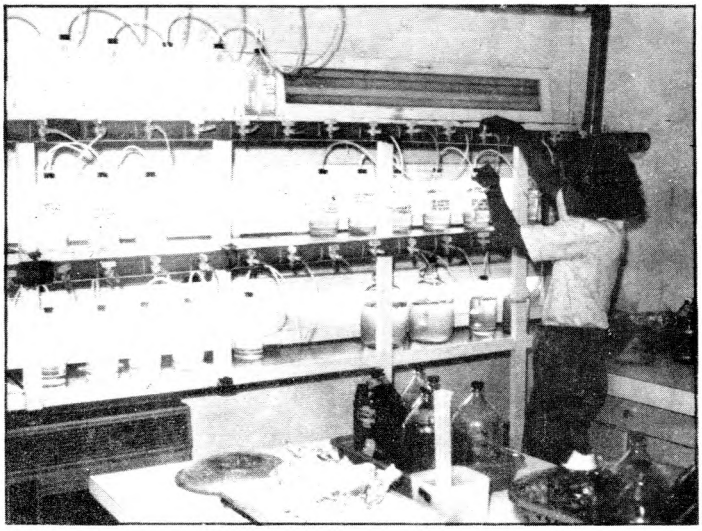
J. Primavera - Round-Table Discussion on Philippine Fisheries Policies, Department of Science and Technology, Metro Manila, 18-20 December

Facilities

Service Laboratories

Larval Food Laboratory

Phytoplankton (10,400 l) and zooplankton (150 l) cultures were used in six research studies and two training courses during the period. Starter cultures of phytoplankton and zooplankton in liquid (1338 l) and solid (71 agar slants) media and 49 sets of enriched media stock solutions were also prepared for private hatchery operators.



Batch cultures of algal food for shrimp and finfish larvae.

Adult *Artemia* biomass was harvested mainly for feeding sea bass larvae used in several AQD research studies. The hatching efficiency of an *Artemia* cyst sample from a Cebu hatchery operator was determined.

Centralized Analytical Laboratory

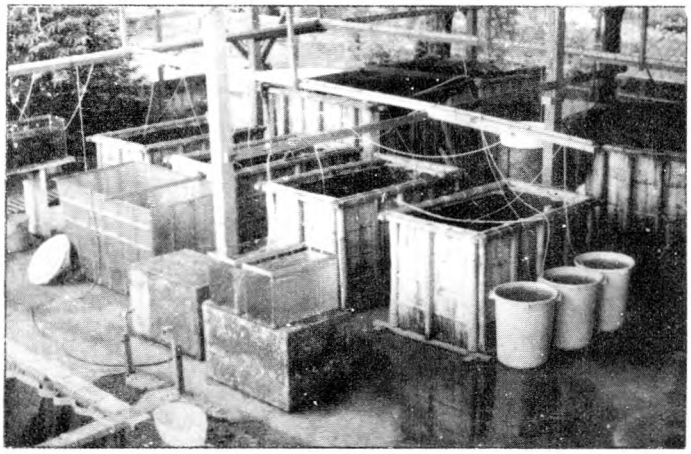
Samples of water (1415), feed (336), and soil (165) were analyzed. Water and feed samples came from ongoing research studies at AQD (97% and 86%, respectively), while the rest came from the private sector. Water samples were analyzed for pH, nitrite-nitrogen, ammonia-nitrogen, orthophosphate, total alkalinity, and dissolved oxygen. Feeds were analyzed for moisture, crude protein, fat fiber, ash, calcium, and phosphorus content. Soil samples mostly came from the private sector (83%) and were analyzed for pH, organic matter, potential acidity, phosphorus, and available iron sulfate.

Diagnostic Services

A total of 267 cases of shrimps (204), finfishes (26), and other samples composed of water, molluscs, and seaweeds (37) were processed during the period. Majority of the cases came from the private sector (89%), the rest from AQD.

Microtechnique Service Laboratory

Some 2,220 samples of various organs and larval stages of finfishes and shrimps were processed during the period. Slide preparations (4,850) were serviced to study leaders of AQD research studies.



National Bangus Breeding Program larval rearing facilities in Pangasinan.

Other Activities

Cooperation with Non-Member Governments and Other Organizations

Government of France

• Staff Development

A. Gallego completed a one-year training on bivalve culture in France in January 1989.

Government of the Netherlands

• Training

Through the Direct Aid to Educational Establishments in Developing Countries Programme, the Government of the Netherlands provided fellowships for six participants from ASEAN countries to attend the Fish Health Management Training course held from 16 February to 14 March 1989 at TRS.

Artemia Reference Center (ARC) of Belgium

• Research Projects

Artemia Applied Technology Programme (3 years: 1987-1990)

Also in collaboration with Belgium Ministry of Foreign Affairs - ABOS.

(a) The use of *Artemia* biomass as a dietary ingredient in formulated diets for *Penaeus monodon* postlarvae.

(b) Feeding of different nutritional quality *Artemia* to finfish and prawn larvae.

(c) Intensive biomass culture of *Artemia* in airwater lift raceway and flowthrough systems.

(d) Effect of *emi-emi* (by product in the manufacture of monosodium glutamate) and chicken manure on *Artemia* cyst and biomass production (yield and quality) in ponds at different salinities.

• Training

Training Course in Culture of Natural Food Organisms

Technical and expert assistance were provided by ARC in the conduct of the training course.

• Staff Development

(1) D. Estenor completed MS degree program in Marine Ecology at Vrije Universiteit Brussels, Belgium in September 1989.

(2) A. Duller and D. Reyes, Jr. trained on *Artemia* research at ARC, Belgium, August-October 1989.

Food and Agriculture Organization (FAO/UNDP)

• Research Projects

(1) Regional research programme on the relationships between ulcerative syndrome in fish and the environment (2 years: 1988-1990).

(2) Histo-chemical studies on the early stages of development of the digestive tract of sea bass, *Lates calcarifer* Bloch (Thesis Research).

• Training

Training Course for Senior Aquaculturists in Asia (1981-1987, 1988-1989)

Eighteen participants completed the one-year seventh UNDP/FAO-NACA-UPV-SEAFDEC/AQD Senior Aquaculturists Training Course, SEAFDEC/AQD Tigbauan, Iloilo, Philippines on 16 March 1989.

International Development Research Centre (IDRC) of Canada

• Research Projects

(1) National Bangus Breeding Program [at the four selected regions in the country (3 years: 1986-1989)]. Ongoing.

Also in collaboration with the Department of Agriculture (DA)- Bureau of Fisheries and Aquatic Resources, Philippines.

(2) Growth, feed utilization, and body composition of young red tilapia given diets with various protein and energy levels (10 months: January-October 1989; Started in January 1989).

(3) Genetic evaluation and selective breeding of *Oreochromis niloticus* for broodstock development (3 years: 1986-1989).

(a) Development of salinity-tolerant hybrids/ strains of *Oreochromis niloticus* for brackishwater culture. II. Growth performance of *O. niloticus, O. mossambicus* and their F_1 hybrids at various salinities. Started in March 1988.

(b) Development of genetic evaluation and selection criteria for tilapia broodstock: IV. Effect of restrictive and non-restrictive feeding on growth of strains of *Oreochromis niloticus*. Started in February 1989.

(c) Development of a high-yield red tilapia strain through introgressive hybridization. Started in March 1989.

(d) Growth performance evaluation of two *Oreochromis niloticus* strain in two lake environments. Started in March 1989.

(4) Fish Microbiology (3 years: 1989-1992)

Also in collaboration with Simon Fraser University, Burnaby, B.C., Canada.

(a) Investigations on the vertical and horizontal transfer mechanisms of the luminescent bacterium, *Vibrio harveyi*, affecting *Penaeus monodon* larvae. Started in June 1989.

(b) Histopathology of epizootic ulcerative syndrome in some freshwater fishes of Laguna de Bay, Philippines. Started in June 1989.

(c) Aquatic fungi in the etiology of epizootic ulcerative syndrome (EUS). Started in September 1989.

(d) Viral and bacterial etiology of the epizootic ulcerative syndrome (EUS). Started in June 1989.

(5) Seafarming in the Philippines: Site selection (1 year: 1989-1990). Started in June 1989.

Ocular survey of 10 potential sites for a pilot seafarming and coastal enhancement center has been conducted. Of 10 sites, 5 candidate sites were selected based on the criteria formulated by the socioeconomics and biological teams. A questionnaire has been drafted and translated into local dialect by the socioeconomic team. Pre-testing of the instrument is ongoing. Linkages with non-government organizations (NGOs) who will assist in project implementation have been established.

• Information

Brackishwater Aquaculture Information System (BRAIS). Phase II (2 years: 1987-1989)

• Staff Development

(1) C. Pitogo attended the 10-day training course in shrimp pathology at the University of Arizona, U.S.A., in July; and also the three-month training course in bacteriology at Simon Fraser University, Burnaby, British Columbia, Canada, in August.

(2) G. Lio-Po, undertook a two-month (September-October) training in fish virology at Pacific Biological Station in British Columbia, Canada, preparatory to a Ph.D. program.

(3) Fellowship grant for a Ph.D. degree program was awarded to Z. Basiao beginning September.

International Foundation for Science (IFS)

• Research Projects

(1) Effect of temperature and ration size on growth and energy utilization of sea bass (3 years: 1988-1991)

(a) Food consumption, feeding rate, salinity and temperature tolerance of sea bass fry and fingerlings; started in April 1989.

(b) Food consumption of sea bass (*Lates calcarifer)* in captivity: Group feeding; started in March 1989.

(2) Isolation and characterization of a female-specific plasma protein (vitellogenin) in milkfish, *Chanos chanos* Forsskal (2 years: 1988-1989; started in January 1989).

(3) Prevention of *Aeromonas hydrophila* infection among *Chanos chanos* (Forsskal) by vaccination (3 years: 1989-1992; started in June 1989).

University of Hohenheim, Germany

• Research Project

Investigation on the energy requirement of milkfish during starvation and growth. (Letter of Intent signed February 1988; MOA under negotiation)

University of Rhode Island (URI)

URI-SEAFDEC/AQDCollaboration (1987-present).

National Institutes and Agencies

Department of Agriculture - Bureau of Fisheries and Aquatic Resources (DA-BFAR)

National Bangus Breeding Program (NBBP) (1980-present).

Philippine Human Resources Development Center

For collaboration in the planning, implementation and review of programs, projects, and activities relevant to aquaculture development in the region (September 1989-present).

UP in the Visayas/UP Diliman - NSRC

Algal food preference and effect on growth of *Placuna placenta* larvae and spat; started in September 1989.

VISITORS AND GUESTS

A stream of visitors and guests visited AQD in 1989. From the general public were investors, fish farmers, teachers, and students. Administrators, policy makers, and officials of different governments also came as well as researchers and scientists of other research institutions.

Among the dignitaries and scientists who visited AQD in 1989 were:

Mr. Luqueman Ahmed, Joint Chief, Ministry of Fisheries and Livestock, Bangladesh

Mr. Romeo Alcasid, Director, Bureau of Animal Industry, DA, Quezon City, Philippines

Dr. B. Amang, Bulog, Indonesia

Senator Agapito Aquino, Chairman, Senate Committee on Agriculture and Food, Philippine Senate, Metro Manila, Philippines

Mr. M. B. Aznar, President, Southwestern University, Cebu City, Philippines

Atty. D. Barbosa, Undersecretary, Department of Agriculture, Quezon City, Philippines

Dr. Thiraphan Bhukaswan, Secretary-General and **Mr. Kazuo Inoue**, Deputy Secretary-General, SEAFDEC Secretariat, Bangkok, Thailand

Mr. Edgar Burnard, Manager, Research and Development, Dampier Division, Western Australia

Mr. Laurent Charbonnet, Vice Consul, and 3 Consulate staff, US Consulate, Cebu City, Philippines

Mr. Fu-Shan Ceng, Chung-An Chen, Taiwan

Dr. Horacio Cocio and **Mr. Vicente Majaducon**, Assistant Regional Directors, Department of Agriculture-VI, Iloilo City, Philippines

Mr. C. Dulay, Provincial Agricultural Officer; and **Ms. H. Trinidad**, Chief, Research Division, Department of Agriculture - Region I, San Fernando, La Union, Philippines

Mr. E. Fabella, Regional Director, DA-Region VI, Iloilo City, Philippines

Mr. Mohammed Farashuddin, Deputy Resident Representative, UNDP, Manila, Philippines

Dr. Graham A.E. Gall, Department of Animal Science, University of California-Davis, California, U.S.A.

Dr. Godofredo Gallega, President, Philippine Association of State Universities and Colleges, and about 400 PASUC members, PASUC c/o West Visayas State University, Iloilo City, Philippines

Dr. Noel Gillespic, Assistant Director, together with Fisheries Biologists **Dr. John Russel** and **Dr. Clive Keener** of the Queensland Department of Primary Industries, Australia

Dr. Vecchi Giuliano and party, Rome, Italy

Hon. Neville Harper, Minister; **Barry White**, Director (Consultancies and Market Development) and **Bob Bygott**, Executive Director (Special Duties), Department of Primary Industries, Queensland Government, Brisbane, Australia

Sri Turni Hartati, Research Institute for Marine Fisheries, Jakarta, Indonesia

Messrs. Noel Herbst, Murray Sipf, Thasik Insom, and **Oscar de la Luna**, Queensland Resources Development Corporation, Brisbane, Australia

Mr. Yukio Hiruma, Yokohama, Japan

Dr. Veravat Hongskul, Outgoing SEAFDEC Secretary-General, Department of Fisheries, Bangkok, Thailand

Mr. Kh. M. Hossain, Research Officer, Ministry of Fisheries and Livestock, Dhaka, Bangladesh

Mr. Moarad Hossain, Research Officer, MOFL, Bangladesh

Messrs. Abrar Jussain, Ghulam Mustafa Gopang, Zafar Ali Quereshi and **Arbind Singh**, Researchers, Pakistan

Mr. K. Kubota, Niigata, Japan

Mr. Katsunobu Kuroki, Fisheries Experimental Station, Kagoshima Perfecture, Kagoshima, Japan

Dr. M.N. Kutty, NACA, Bangkok, Thailand

Messrs. Dave Larson, Gary Edwards, and **Howard Lapides**, CARGYLL, U.S.A.

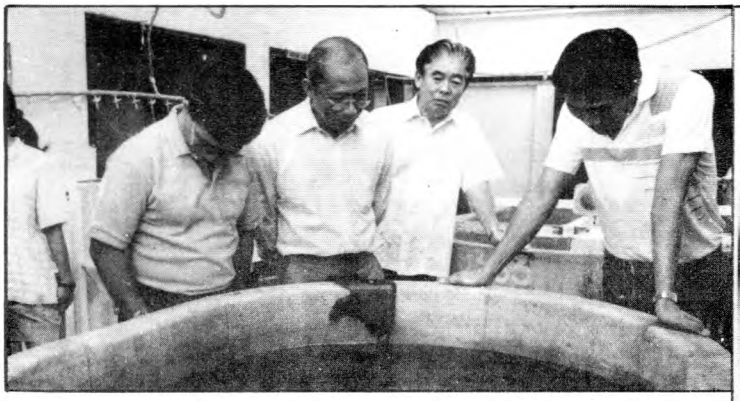
Mr. W.H. Lee, Kunsan National University, Kunsan, Korea

Mr. Thomas Lindemann, Deputy Resident Representative, FAO, Manila, Philippines

Prof. Eduardo Lopez, Central Luzon State University, Muñoz, Nueva Ecija, Philippines

Sen. Pilar Lujan, Legislative Secretary, Territory of Guam, U.S.A.

Dr. Graham C. Mair, University of Wales, Col-



Guests and visitors are a common sight at AQD. Top (from left), Congressmen David Ponce de Leon and Oscar Santos, with the Department Chief and Department Deputy Chief; right, Dr. Thiraphan Bhukaswan, SEAFDEC Secretary-General, with AQD Administrative Division Head.

lege of Swansea, U.K.

Mr. Md. A. Majid, Assistant Chief (Planning), Directorate of Livestock Services, Dhaka, Bangladesh

Mr. A.N. Marasigan, and participants in the UNESCO Regional Worskhop on Marine Phytoplankters in the Southeast Asian Region, UPV, Miag-ao, Iloilo, Philippines

Dr. M. Martirez, UPLB-UNESCO, Los Baños, Laguna, Philippines

Mr. Andrew McNaughton, Program Officer (Aquaculture and Artisanal Fisheries), IDRC, Singapore

Kamal Zaman Mohammed, Fisheries Research Institute, Glugor, Penang, Malaysia

Mohammed Abdul Mojid, Asst. Chief, Planning and Livestock Services, Bangladesh

Dr. P.K. Mukhopadhyay, Fish Scientist, Deepwater Rice Project of India

Dr. Yont Musig, ThaiBRAIS Project Leader, Kasetsart University, Bangkok, Thailand

Mr. Michael B. New, Coordinator, ASEAN-EEC Aquaculture Development and Coordination Programme, Department of Fisheries, Bangkok, Thailand

Messrs. Yang Ningsheng, Director of Information Resources; **Wang Yu**, Vice-Director and **Zheng Weizhong**, Chinese Academy of Fishery Sciences, Beijing, People's Republic of China

Mr. Enzo Pezzini and **Mr. Savino Marinelli,** MEDIACOOP, Italy

Mr. R. Piadozo, Dept. of Community and Environmental Resources Planning, College of Human Ecology, UP Los Baños, Laguna

Mr. Augusto Pongos, RAFC Chairman, Ormoc City, Philippines

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Dr. M.S. Shah, Fisheries Research Institute, Bangladesh

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Mr. Sutomo, Indonesian Institute of Sciences, Jakarta, Indonesia

Dr. Valle and **Mr. Ikeda,** International Rice Research Institute, Los Baños, Laguna, Philippines

Mr. A. Whipp, Roussel UCLAF, Singapore

Mr. James Winfree, Jr., Louisiana State University, Baton Rouge, U.S.A.

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APPENDICES

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Marte CL, Lam TJ. Seasonal and diurnal hormone changes in different ages of immature milkfish (*Chanos chanos*). *XIth International Symposium on Comparative Endocrinology;* Malaga, Spain; 14-20 May.

Millamena OM. Effect of dietary lipid sources on reproductive performance of *Penaeus indicus* broodstock. *Fifth International Congress on Invertebrate Reproduction;* Nagoya, Japan; 23-28 July.

Pascual FP, Catacutan M. Defatted soybean meal and *Leucaena* meal as protein sources in diets for *Penaeus monodon* juveniles. *Second Asian Fisheries Forum;* Tokyo, Japan; 17-22 April.

Piedad-Pascual F. Mineral requirements of penaeids. *Advances in Tropical Aquaculture:* Nutrition of Crustaceans; Tahiti, French Polynesia; 24-28 Feb.

Primavera JH. Effects of fisheries and aquaculture on the environment. *PCMARD Roundtable Discussion on Philippine Fisheries Policies;* Department of Science and Technology; Metro Manila; 12-13 Dec.

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Romana MRR. Effects of dietary stress on Nile tilapia fry (Poster presentation). *Second Asian Fisheries Forum;* Tokyo, Japan; 17-22 April.

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Tan-Fermin JD, Garcia LMaB, Castillo AR. Induction of sex inversion in juvenile grouper, *Epinephelus malabaricus* (Bloch and Schneider), by biweekly injections of 17 α–methyltestosterone. *International Symposium on Hormones and their Environment;* University of Hongkong; 18-20 December.

Villegas CT. Growth performance and survival rates at various salinities of *Oreochromis niloticus, O. mossambicus* and their F_1 hybrids. *Second Asian Fisheries Forum;* Tokyo, Japan; 17-22 April.

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RESEARCH

Agbayani, Renato	M.B.A. (Business Management) University of the Philippines, Diliman 1972	Aquaculture Economics
Alava, Veronica	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1979	Aquaculture Nutrition
Almendras, Jesus Manolo	M.S. (Marine Biology) University of the Philippines, Diliman 1982	Fish Physiology
Aralar, Ma. Lourdes	M.S. (Biology)/M.S. (Zoology) University of the Philippines/ Glasgow University, 1984/1985	Lake Ecology
Avila, Enrique	Ph.D. (Biology) University of Heidelberg 1987	Fish Biology

Ayson, Felix	M.S. (Marine Biology) University of the Philippines, Diliman 1987	Fish Breeding
Bagarinao, Teodora*	M.S. (Marine Biology) University of California, San Diego 1982	Larval Ecology
Baldia, Susana*	M.S. (Biology) University of the Philippines, Diliman 1984	Larval Pond Culture
Basiao, Zubaida*	M.S. (Zoology) University of the Philippines, Diliman 1976	Aquaculture Genetics
Baticados, Ma. Cecilia	M.S. (Biology)/M. Aquaculture University of the Philippines, Diliman/ University of the Philippines in the Visayas 1980/1983	Fish Health
Bautista, Myrna	M.S. (Food Science) University of the Philippines, Diliman 1980	Aquaculture Nutrition
Bombeo, Ruby	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1983	Larval Food Culture
Borlongan, Ilda	M.S. (Chemistry) University of the Philippines, Diliman 1982	Aquaculture Nutrition
Buensuceso, Robmar	M. Aquaculture University of the Philippines in the Visayas 1989	Mollusc Culture
Castillo, Antonio	M.S. (Fisheries) Miyazaki University 1988	Fish Hatchery
Catacutan, Mae*	M.S. Fisheries (Marine Animal Nutrition) Kagoshima University 1982	Aquaculture Nutrition
Cheong, Ronald**	M.S. Fisheries Louisiana State University 1986	Seafarming
Coloso, Relicardo*	M.S. (Biochemistry) University of the Philippines, Diliman 1980	Aquaculture Nutrition

De Castro, Ma. Teresa	M.S. (Environmental Engineering) University of the Philippines, Diliman 1982	Seaweed Culture
De la Peña, Milagros	M.S. (Marine Biology) University of the Philippines, Diliman 1983	Larval Food Culture
Dogma, Jr., Irineo**	Ph.D. (Botany) University of Michigan 1970	Fish Health
Duray, Marietta	M.S. (Biology) University of San Carlos 1977	Fish Hatchery
Emata, Arnil*	M.S. (Zoology) Louisiana State University 1983	Fish Breeding
Estenor, Demetrio	M.S. (Marine Ecology) Vrije Universiteit 1989	Larval Food Culture
Estepa, Fe Dolores	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1982	Crustacean Hatchery
Eusebio, Perla**	M.S. (Animal Science) University of the Philippines at Los Baños 1978	Aquaculture Nutrition
Fermin, Armando	M.S. (Aquaculture) Central Luzon State University 1985	Fish Hatchery
Fermin, Josefa	M.S. (Zoology) University of the Philippines, Diliman 1982	Fish Breeding
Fernandez, Roselyn*	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1983	Fish Health
Gallardo, Wenresti**	M. Aquaculture University of the Philippines in the Visayas 1989	Mollusc Culture
Gallego, Amalia*	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1986	Fish Hatchery

Garcia, Luis Maria	M.S. (Zoology) University of Alberta 1984	Fish Physiology
Golez, Nelson	M. Agriculture (Agricultural Chemistry) Kyoto University 1988	Soil Chemistry
Gonzal, Angelito	B.S. (Chemical Engineering) Adamson University 1979	Fish Breeding
Javellana, Gilda	M.S. (Zoology) University of the Philippines, Diliman 1985	Crustacean Hatchery
Lacanilao, Flor	Ph.D. (Fish Physiology) University of California at Berkeley 1971	Fish Breeding
Lacierda, Erlinda	M.S. (Marine Biology) University of the Philippines, Diliman 1981	Fish Health
Ladja, Jocelyn	M. Aquaculture University of the Philippines in the Visayas 1989	Mollusc Culture
Lio-Po, Gilda	M. Public Health (Microbiology) University of the Philippines, Manila 1973	Fish Health
Marte, Clarissa	M.S. (Zoology) University of the Philippines, Diliman 1971	Fish Breeding
Millamena, Oseni	M. Engineering (Environmental Engineering) Asian Institute of Technology 1968	Aquaculture Nutrition
Palisoc, Fermin Jr.	M.S. (Zoology) University of the Philippines, Diliman 1982	Fish Health
Parazo, Monina	M.S. Fisheries (Nutritional Chemistry) Kagoshima University 1987	Aquaculture Nutrition
Pascual, Felicitas	Ph.D. (Nutrition) Iowa State University 1968	Aquaculture Nutrition

Peñaflorida, Veronica	M. Agriculture (Animal Science) West Visayas State College 1979	Aquaculture Nutrition
Pitogo, Celia	M.S. (Marine Biology) University of the Philippines, Diliman 1984	Fish Health
Ponce, Anicia**	D. Agriculture (Phycology) Kyoto University 1988	Seaweed Culture
Primavera, Jurgenne	M.A. (Zoology) Indiana University 1969	Crustacean Breeding
Quinitio, Emilia	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1980	Crustacean Breeding
Quinitio, Gerald	D. Fisheries Science Hokkaido University 1989	Fish Breeding
Rodriguez, Edward	M.S. Fisheries Science Nagasaki University 1987	Pond Culture
Romana, Ma. Rowena	M.S. (Genetics) University of Wales 1985	Aquaculture Genetics
Samonte, Giselle**	M. Management University of the Philippines at Los Baños 1988	Aquaculture Economics
Santiago, Alejandro	M.A. (Zoology) Indiana University 1978	Lake Ecology
Santiago, Corazon	Ph.D. (Fish Nutrition) Auburn University 1985	Aquaculture Nutrition
Solis, Noel	M.S. (Biology)/M. Aquaculture University of San Carlos/University of the Philippines in the Visayas 1976/1983	Ecology and Pond Culture
Subosa, Prescilla	B.S. (Chemical Engineering) Mapua Institute of Technology 1971	Aquaculture Nutrition

Sumagaysay, Neila**	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1988	Pond Culture
Tamse, Catherine*	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1979	Fish Health
Toledo, Nieves*	M.S. (Fisheries) Kagoshima University 1988	Crustacean Breeding
Triño, Avelino	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1986	Pond Culture
Tuburan, Isidra	M.S. Fisheries (Aquaculture) University of the Philippines in the Visayas 1980	Pond Culture
Ver, Leo Michael*	M.S. (Marine Biology) University of the Philippines, Diliman 1981	Shellfish Culture
Villegas, Cesar	Ph.D. (Plant Breeding) Iowa State University 1970	Aquaculture Genetics
Young, Paciencia*	M.S. (Biology) University of San Carlos 1978	Larval Physiology

TRAINING AND INFORMATION

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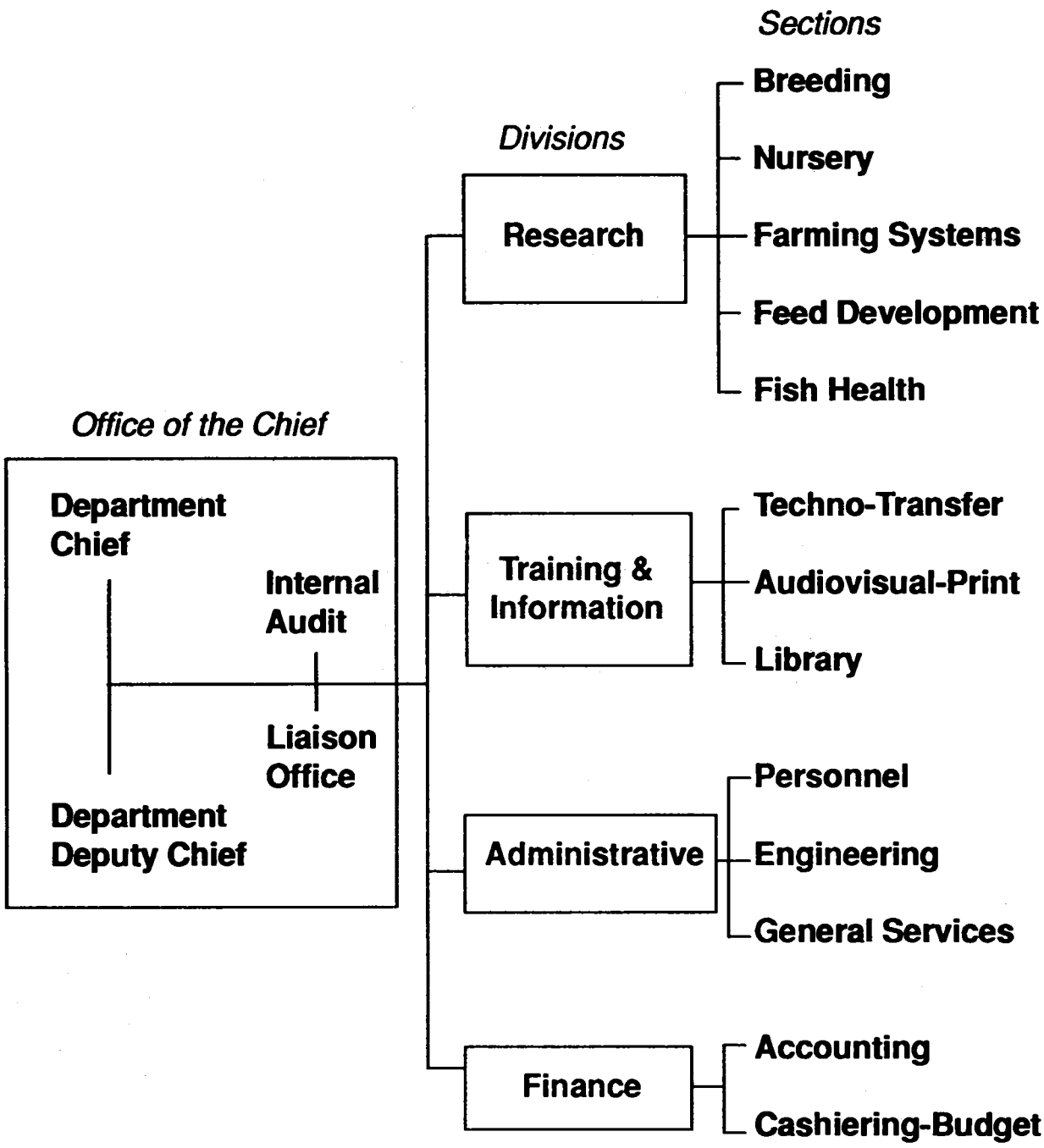
AQD ORGANIZATIONAL CHART



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